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ANNALS *of* SURGERY

Vol. XC AUGUST, 1929 No. 2

EVALUATION OF BLOOD CLOTTING FACTORS IN SURGICAL DISEASES

WITH SPECIAL REFERENCE TO THROMBOSIS AND EMBOLISM AND CERTAIN BLEEDING CONDITIONS

By Frederic W. Bancroft, M.D., I. Newton Kugelmass, M.D.

AND

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OF New York, N. Y.

FROM THE DEPARTMENTS OF SURGERY AND PEDIATRICS OF THE FIFTH AVENUE HOSPITAL

The surgical calamities of phlebitis and of embolism face every surgeon in almost any operation he may perform. They arise often without noticeable warning, and the results are heartbreaking. To have a patient, following an interval appendicitis operation, suddenly die on the eve of leaving the hospital is a most disturbing calamity. Thrombosis and embolism have been subjects of study by many clinics. We may assume, probably without danger of contradiction, that the following etiological factors are considered to be the most important:

(1) Trauma; (2) infection; (3) slowing of the blood stream; and (4) increased viscosity of the blood.

We believe that these factors are necessary to create thrombosis and phlebitis; but many patients probably have all of these factors present and yet do not develop phlebitis or thrombosis, while other patients with a minimum number of the factors readily succumb. Assuming, therefore, that there must be a variant in the constituents of the blood of patients which may predispose toward thrombosis, we decided to make a routine quantitative study of the factors involved in blood clotting in the case of all patients admitted into the surgical service of the Fifth Avenue Hospital.

It has been demonstrated clinically that the bleeding and clotting time is not always a true indication of the degree of the patient's blood coagulability; hence quantitative determination of each individual factor of clotting has been studied. We felt that if every case were examined before operation, and then three and five days post-operative examinations were made, we might be able to determine the normal and abnormal reactions to surgical procedures. In all, two hundred cases have been thus examined. We knew that food and certain drugs affected the blood-clotting constituents, and, therefore, we felt that if we could predict a predisposition to either clot or bleed we might be able to correct the defect. Through the generosity of Mr. Charles Frueauff we have been able to employ a full-time technician to study this problem. We feel that our results thus far are significant, and justify this preliminary report. The scope of the work has carried us over a larger field than we had anticipated; because, with the study of clotting, we soon found that certain types of bleeding came under our study. We wish, therefore, to report

briefly on certain cases of bleeding that will later be the basis of special reports. Our present report includes:

(1) Cases of thrombosis and embolism; (2) bleeders, studied in reference to tonsillectomy; (3) new-borns with hæmorrhagic disease; (4) the dietary treatment of bleeding and clotting conditions.

On initiating these investigations the following tests were made on every case, save emergencies, admitted to the hospital:

(1) The bleeding and clotting time; (2) the prothrombin index; (3) the antithrombin index; (4) the fibrinogen content; (5) platelet count; (6) the degree of platelet disintegration; (7) analysis, from the above tests, of the blood-clotting function index.

Recently we have omitted the bleeding and clotting time, as we obtained very little information therefrom. At first, tests were taken before breakfast, or with the omission of breakfast, but of late we have found that blood taken two or three hours after breakfast shows no variation, so that the procedure is simplified thereby.

In order to amplify the theories on which we have based our work we mention briefly the accepted mechanism of blood coagulation and the accepted theory for thrombosis. In addition we include in detail the methods of determining the various blood-clotting substances.

Determination of the Blood-Clotting Function.—Hæmorrhagic diatheses constitute a group of disorders resulting from a deficient blood-clotting mechanism. The variety of hæmorrhagic affections has not been satisfactorily classified because of the complexity of the clotting process. Recent advances in chemistry,[1] however, have made it possible to determine the character of the substances involved in the coagulation of blood. This knowledge provides a more substantial basis for the early recognition, prevention and treatment of hæmorrhagic diseases.

Physicochemical studies reveal that blood plasma, so long as its constituents are not dissociated by extraneous forces, is a single complex in equilibrium, rather than a mixture of substances. The initial views of Harvey (1653) and of Woodridge (1886) have come into their own again—"blood plasma is protoplasm and clotting is the last act of living blood".

Blood when shed exhibits the striking physiological function of dissociating into the components necessary for the clotting reaction. The blood-clotting function then depends first on the degree of dissociation of plasma—the incubation period of clotting—and second, on the liberation of certain substances in sufficient concentration to form a gel—the actual clotting. The dissociation of shed blood adequate to yield a clot is a determining preclot function.

A graphic presentation of this process would be as follows:

$$\underbrace{\text{[Prothrombin]} + \text{[Cephalin]}}_{\text{Period of Plasma Dissociation}} \underset{\text{Antithrombin}}{\overset{\text{Contact Catalysis, } (Ca^{++})}{\rightleftharpoons}} \underbrace{\left.\begin{matrix}\text{[Thrombin]} \\ + \\ \text{[Fibrinogen]}\end{matrix}\right\}\text{Fibrin}}_{\text{Period of Clotting}}$$

EVALUATION OF BLOOD CLOTTING FACTORS IN SURGICAL DISEASES

BLOOD-CLOTTING MECHANISM

When blood is shed the plasma dissociates into substances which yield a clot. During the patent period of dissociation antithrombin is precipitated and prothrombin is activated by calcium ions. The resulting thrombin gels soluble fibrinogen into insoluble fibrin.

FACTORS PRODUCING CLOTTING IN THE BLOOD STREAM

Having reviewed the accepted mechanism of normal clotting, we must now consider what happens in abnormal conditions, and why, in diseases and trauma, we find spontaneous clotting in the blood-stream. The three factors which are most commonly recognized as producing spontaneous blood clotting are (1) changes in the character of the blood; (2) changes in the rate of the blood flow, and (3) changes in the vessel walls.

It has long been recognized that a clot can be started by throwing out to the periphery the blood platelets when the circulation is slowed down. As these blood platelets clump along the portion of the vessel wall there takes place a coagulation of the blood, forming a red clot around this nucleus of platelets. The great question which comes up is whether this formation of clot can take place with only a slowing of the circulation or trauma, or whether there must be first a change in the blood-clotting elements of the blood. Some [2] writers feel that mild damage to the liver stimulated fibrinogen formation: Others [3] think it is an interaction of the liver and the adrenals. One of the most interesting pieces of work has been done by C. A. Mills [4] in connection with the effect of diet on clotting and basal metabolism. In this work he shows that a carbohydrate and fat diet will raise the basal metabolism, but will not increase clotting, while a protein diet not only raises the basal metabolism, but definitely increases the blood-clotting elements. He attributes this to some unknown factor connected possibly with the amino acids derived from protein metabolism. The quantitative determination of the dissociated compounds involved in blood coagulation is a measure of the clotting function of blood. Such a study indicates the nature of the clotting deficiency and hence the hæmorrhagic status of a patient. The total number of determinations may be carried out in an hour.

Our approach to the solution of bleeding problems has been to quantitate the clotting components as a basis for the classification of hæmorrhagic diatheses as well as for the administration of rational therapy.

Clotting Time (General Statement).—The blood-clotting time is essential, but not conclusive for determining the hæmorrhagic tendency of a patient. The clotting time may be normal though spontaneous bleeding be present, *i.e.*, in purpura and jaundice, and clotting may be delayed although there be no hæmorrhage.

The determination of the clotting time of blood passing through skin is no criterion of the true clotting status of blood and hence no indication of

what might be expected in the operative field of other tissue. All injured tissues, as well as blood when shed, dissociate into substances conducive to their coagulation. This contributory tissue factor may be eliminated by taking the clotting time by vein puncture.

Clotting Time (Vein Puncture).—Draw one cubic centimetre of blood and transfer to a test tube eight millimetres in diameter (the greater the diameter of the tube, the slower the clotting). Place the tube in a water bath at 38° C.* Coagulation is complete when the tube can be inverted without displacing the clot. (Normal, five to eight minutes.)

Clotting Time (Skin Puncture).—Touch the end of a capillary tube (3 cm. x 0.6 mm.) to the first drop of blood issuing from a stab in the finger or ear. Place in the creases of the palm and cover by closing the hand to maintain a fairly uniform temperature (34°–35° C.). The clot *initiation time* (latent period) is the first visible departure from fluidity. The clot *formation time* is the first fibrin thread seen between the ends when the capillary is broken by bits every half minute. (Normal, three to five minutes.)

Antithrombin (Definition and Characteristics).—Antithrombin is the substance maintaining the stability of the plasma complex. When blood is shed the dissociation of the plasma produces clotting components which, by mass action, decrease the stabilizing effect of the antithrombin. Its content is directly proportional to the colloid stability of the blood. High antithrombin values indicate a hæmorrhagic tendency and low values indicate accentuated coagulability of blood.

Antithrombin Index.[5]—Blood obtained by skin puncture is drawn into a Wright tube, allowed to clot and then centrifuged, 0.1 cubic centimetre serum is drawn off into a small test-tube by means of a capillary pipette and heated in a water bath at 60° C. for ten minutes. (Prothrombin is thus destroyed.) A control blood is carried through the same procedure. The heated serums are cooled and to each is added 0.3 cubic centimetre prepared thrombin solution. The tubes are placed in a water bath at 38° C. for fifteen minutes. An 0.5 cubic centimetre prepared fibrinogen solution is finally added to each tube and the clotting time is observed at 38° C. The antithrombin index is the ratio of the clotting time of the patient's blood to that of the control.

TABLE I

Antithrombin Test

Heated serum c.c.	Thrombin c.c.	Fibrinogen c.c.	Clotting time at 38° C. Control	Patient
0.1	0.3	0.5	5 minutes	x

Incubation time, 15 minutes

Preparation of Fibrinogen.—Blood from the slaughterhouse is drawn into a vessel containing sufficient sodium citrate to give a final concentration of 0.5 per cent. The plasma is collected by centrifugation and to each twenty-five cubic centimetres are added four grams of sodium chloride. The precipitate fibrinogen is collected, washed several times in 15 per cent. sodium chloride containing 0.5 per cent. sodium citrate and finally dissolved in twenty-five cubic centimetres of 0.5 per cent. sodium citrate.

Preparation of Thrombin.—Twenty-five cubic centimetres of the plasma, collected

* A suitable thermostat consists of an unsilvered Dewar tube containing water at 38° C. and covered with a cork with holes for small test tube.

by the above procedure, is precipitated by ten grams of ammonium sulphate and filtered by means of a Buchner suction funnel. The ammonium sulphate is expressed as completely as possible to obviate the necessity for dialysis. The precipitate containing the plasma prothrombin may be preserved for weeks as a moist paste. The thrombin solution is prepared by dissolving 0.25 grams of the paste in ten cubic centimetres of water, adding two cubic centimetres of an 0.1 per cent emulsion of cephalin and 2 cubic centimetres of a one per cent. solution of $CaCl_2.6H_2O$. This thrombin solution remains active for several hours.

Prothrombin.—Prothrombin is a protein substance identified with albumin and globulin and is electro-negative in blood. It acts as a nucleus of electrical condensation of the clotting components in the formation of a gel. Its concentration is directly proportional to the clotting activity of blood. High values indicate accentuated coagulation of blood and low values indicate a tendency to bleeding.

Prothrombin Index.[6]—Blood obtained by skin puncture is drawn into a Wright tube containing 0.1 cubic centimetres of 1 per cent. sodium oxalate and centrifuged. One-tenth cubic centimetre of the plasma is placed in three tubes (6.8 x 1.3 cm., flat bottom) in a water bath at 38° C. and to these are added in series 0.1, 0.2, 0.3 cubic centimetre of 0.5 per cent. $CaCl_2.6H_2O$. The shortest clotting time in the series is the prothrombin time. The prothrombin index is the ratio of the clotting of the control to that of the patient's blood.

TABLE II

Prothrombin Test

Oxalated plasma	0.5 per cent. $CaCl_2$	Clotting time at 38° C.	
c.c.	c.c.	Control 3 minutes	Patient x
0.1	0.1		
0.1	0.2		
0.1	0.3		

Fibrinogen.—Fibrinogen constitutes the potential clot structure dispersed in the plasma in the most readily precipitable form. Its transformation into soluble fibrin completes the clotting reaction. High fibrinogen content accelerates clotting and synæresis or retraction of the firm fibrin clot from the gel. Low fibrinogen content gives a non-resistant skein inadequate for retraction in arresting hæmorrhage.

Fibrinogen Value.[7]—Blood is drawn into a tube containing 0.2 cubic centimetres of 3.5 per cent. sodium citrate and centrifuged under albolene. The refractive index of one drop of the plasma at 38° is estimated by means of a Pulfirich Refractometer. One-tenth cubic centimetre of 1.5 per cent. $CaCl_2.6H_2O$ is added to the tube to coagulate the fibrinogen, and is then centrifuged. The refractive index of a drop of the serum is then determined. The percentage of the blood fibrinogen is the difference between the indices of plasma and serum multiplied by the factor 0.187.

DETERMINATION OF PLATELETS

Platelets are lipoidal protoplasmic separations from megakaryocytes in the bone-marrow. Clotting of blood takes place, other factors being equal, when there is an adequate platelet content and a rapid platelet disintegration, liberating phosphatides. In fact platelets which do not agglutinate rapidly are functionless for clotting.

Platelet Count.—Draw blood with a red blood count pipette and dilute with 3 per cent. citrate (1:200) without adding any stain as a diluting agent. Allow the cell to stand for ten minutes before counting the platelets in the customary counting chamber.

Platelet Lysis Percentage.[5]—Blood is collected into a short paraffined tube and platelet counts are made at fifteen-minute intervals, counting only those which are single and not agglutinated into clumps. The platelet lysis percentage is the fraction of the platelets which disintegrates within one hour.

Calculation of the Index of Blood-Clotting Function.—Normal blood shows on analysis that the clotting components are contained in fairly constant concentrations. Typical normal values are given as representative of determinations made on patients with normal blood-clotting function.

TABLE III

Blood Analysis of Clotting Components (Normal Values)

Name	Diagnosis	Clotting time	Bleeding time	Prothrombin	Fibrinogen	Antithrombin	Platelets	Platelet disintegration	Clotting index
					Per cent.			Per cent.	
	Post-auricular abscess	5′15″	1′30″	1.0	0.56	1.04	240,000	40	0.5
	Chronic appendicitis	3′30″	2′30″	1.0	0.54	1.0	300,000	50	0.5
	Cysto-pyelitis	4′30″	1′30″	1.0	0.54	1.0	350,000	71	0.5
	Perineal repair	4′15″	2′0″	1.0	0.60	1.0	225,000	59	0.6
	Recto-vaginal fistula	5′0″	2′0″	1.0	0.64	1.04	185,000	45	0.6

The constancy of the values in blood-clotting functions is evident from the above data on some of the patients studied as controls. The variation in platelets is within the accepted normal range. We have come to believe that high platelet counts are associated with chronic infections.

The rate of platelet disintegration at the end of one hour is over 40 per cent., the low normal level.

A composite value of the ability of a blood to clot may be calculated from these determinations. Certain of the blood substances, *i.e.*, prothrombin, fibrinogen and platelets, tend to favor clotting, and others (antithrombin) tend to reverse this process, *i.e.*, favor bleeding. In this chemical mechanism the activity for clotting or bleeding is proportional to the concentration of each interactive substance.

$$\begin{matrix}\text{Prothrombin} \\ + \\ \text{Fibrinogen}\end{matrix} \quad + \quad \text{Platelets} \quad \rightleftharpoons \quad \text{Antithrombin}$$

Expressing this reaction in terms of the law of mass action, we have

$$\frac{[\text{Prothrombin}]\ [\text{Fibrinogen}]\ [\text{Platelets}]}{[\text{Antithrombin}]} = 1$$

Introducing normal values for these substances,

Prothrombin Index	= 1
Fibrinogen	= 0.5 per cent.
Platelets	= 200,000
Platelets Lysis	= 50 per cent. in 1 hr.
Active Platelets	= 100,000
Antithrombin Index	= 1.0

The normal index of clotting function of blood is, therefore, 0.5 ± 0.2. Values over 1.0 indicate a marked tendency to clot and values below 0.2 indicate a marked tendency to bleed.

TABLE IV

Blood Analysis in Diseases with Altered Clotting Function

	Name	Diagnosis	Clotting time	Bleeding time	Prothrombin	Fibrinogen	Antithrombin	Platelets	Platelet Disintegration	Clotting Index
Bleeding Cases		Hemophilia	10′0″		1.00	Per cent. 0.64	1.11	95,000	Per cent. 15	0.008
		Hæmorrhagic disease new-born	11′15″		0.66	0.19	1.5	165,000	20	0.04
		Hemophilia	5′0″	4′0″	0.66	0.54	1.57	250,000	24	0.2
		Nutritional bleeder	4′30″		0.87	0.46	1.25	240,000	62	0.3
Clotting Cases		Mesenteric thrombosis	2′30″	1′30″	1.54	0.93	0.75	440,000	67	1.9
		Gall-stones Gastric polyp Complication—thrombosis	3′30″		1.54	0.93	0.75	300,000	50	1.9
		Cardiac with embolus in popliteal artery	3′15″	4′30″	1.7	1.12	0.46	275,000	83	4.1

The clotting function index has been a more accurate clinical criterion of the condition of the patient than has hitherto been available by laboratory methods. In certain chronic diseases, however, in which the platelets have been markedly increased, no direct relation has been observed between the unusually high clotting index and the possibly increased blood coagulability. We have therefore evaluated the clotting function from the limiting factors:

$$Ia = \frac{[\text{Prothrombin}]\ \ [\text{Fibrinogen}]}{\text{Antithrombin}}$$

The normal index thus becomes 0.5 ± 0.2.

TABLE V

Classification of Diseases in Which Blood-Clotting Function is Altered

				Prothrombin	Fibrinogen	Antithrombin	Platelets
Blood-clotting function in disease	Increased Index > 0.8	Infection	Thrombosis	+		−	
			Thrombo-angiitis obliterans		+		+
			Phlebitis	+		−	
			Pneumonia		+		+
			Tuberculosis				+
		Metabolic	Diabetic gangrene				+
			Cholelithiasis	+	+	−	
			Renal colic		+		
			Carcinoma				+
	Normal Index = 0.5	Physical	Trauma				
			Congestion				
			Hypertension				
			Surgical				
	Decreased Index < 0.2	Hereditary	Melena neonatorum	−			lysis decreased
			Hemophilia				
			Epistaxis				
			Hemoptysis				
		Blood	Secondary anæmia	−	−	+	
			Pernicious anæmia				−
			Chlorosis				−
			Leukemias	+			
		Liver	Stenosis bile-duct				−
			Cirrhosis	−			−
			Jaundice				−
		Infections	Acute infectious			+	−
			Typhoid		−	−	−
			Syphilis				−
			Arthritis			+	
		Toxic	Purpura				−
			Benzol allergy	−			−

THROMBOSIS AND EMBOLISM

In carrying on this work it has been our plan to analyze cases and to attempt, by studying the various factors of blood clotting, to see if we could discover one variant, or one single test, that would indicate the blood picture.

Our first index was formed from the following factors: Prothrombin index, antithrombin index, fibrinogen content, platelet count, and the degree of platelet disintegration. A study of the platelet count and platelet disintegration rate showed that infection, especially in such cases as tuberculous peritonitis, was too great a variant to be a satisfactory guide for clotting factors, so the platelet count and platelet disintegration rate were eliminated.

The next index used consisted of prothrombin, fibrinogen and antithrombin. With this as a basis, our entire series of cases was again reviewed. The actual thrombosis and embolism cases still remain in this group, but the per-

TABLE VI

Case	Operation	Disease	Blood index				Type of blood condition	Treatment of second operation	Course
			1	2	3	4			
I J. C.	Embolectomy	Myocarditis	4.1 Ind.				Myocarditis, embolus in femoral artery	Embolectomy, amputation of thigh	Amputation—Death thirty-fifth day. Myocarditis
			.46 A.						
II R.M.	Excision gastric polyp and cholecystectomy	Cholelithiasis	0.9 Ind.	1.9 Ind.			Embolus in brachial artery sixth day post-operative	Embolectomy	Death in twenty-four hours
			1 A.	.7 A.					
III F. F.	Mesenteric thrombosis	Myocarditis	1.9 Ind.	1.5 Ind.	1.9 Ind.		Mesenteric thrombus femoral embolus	1–Enterostomy 2–Resection of intestine 3–Closure of enterostomy	Death forty-eighth day. Signs of thrombosis in iliac arteries Myocarditis
			.7 A.	.7 A.	.7 A.				
IV R. H.	Appendectomy	Chronic appendicitis		1.6 Ind.			Pulmonary embolus ninth day Phlebitis left Intravenous saphenous thirtieth day	Intravenous injection of gentian violet for phlebitis	Gradual recovery Quick subsidence of phlebitis after injection
				.8 A.					
V C. R.	Laparotomy Pelvic repair Appendectomy	Retroversion lacerated cervix and perineum	0.6 Ind.	0.7 Ind.	0.6 Ind.	1.4 Ind.	Left phlebitis femoral vein eleventh post-operative day	Intravenous injection of gentian	Temperature normal in seven days
			1 A.	1 A.	1 A.	0.8 A.			
VI J. B.		Thrombosis of brachial vein	1.0 Ind.	1.9 Ind.	0.5 Ind.		Thrombosis	Elevation Diet	Left hospital at end of ten days Slow convalescence
			.8 A.	.8 A.	1 A.				
VII B.		Phlebitis		1.8 Ind.			Saphenous vein	None	Elevation of leg and diet
				.8 A.					
VIII H. F.		Thrombosis	.7 Ind.	2 Ind.	2 Ind.	1.3 Ind.	Both iliac veins	None	Pellagra on first admission Put on high protein diet
			.7 A.	.7 A.	.8 A.	.8 A.			
IX S. D.	Salpingostomy Appendectomy	Chronic salpingitis Chronic appendicitis		0.9 Ind.			Phlebitis	Intravenous injection of gentian violet	Slow convalescence
				0.8 A.					
X L.		Phlebitis		1.2 Ind.			Phlebitis following pregnancy	Rest in bed	Slow convalescence
				.8 A.					
XI S. L	Cholecystectomy. Appendectomy	Cholelithiasis chronic appendicitis	0.5 Ind.				Phlebitis of internal saphenous vein	None	Hæmatoma in wound and infection. Phlebitis three days after leaving hospital
			0.8 A.						

centage of high indices (33 per cent.) in the post-operative cases not showing definite phlebitis was too high to be of value from a prognostic viewpoint. Therefore, after studying prothrombin and fibrinogen, and finding that they had no real value as an index, we found that antithrombin used as an index included all of our definite thrombosis and embolism cases and gave only 18

per cent. of suspects in the unproved cases. If by further study this test can be shown to be a reliable index the procedure can be simplified and so arranged that it can be performed as a routine test by a technician.

The blood of 205 cases has been examined in a routine manner both pre- and post-operatively on the Surgical Service of the Fifth Avenue Hospital. In this series we have studied eleven cases who have had thrombosis, phlebitis or embolism. The abbreviated histories of these cases are tabulated below.

Our clotting index of 0.5 is normal and any increase over 0.7 is suggestive of increased clotting tendencies. With antithrombin as an index 1 is considered normal and any decrease below 0.9 is suggestive of increased clotting. In the table both the results of the blood clotting index (Index) and the antithrombin determinations (A) are given.

CASE I.—J. C., a woman, sixty-four years of age, was admitted to the Medical Service March 15, 1928. She had had heart trouble for two years, and was admitted with generalized œdema and acute cardiac failure. Six days after admission she complained of sudden pain in the left leg about the knee. She was seen by the surgical department four hours later, at which time no pulsation of the femoral artery could be felt beyond Poupart's. Her leg was cold to the knee, and there was an area of discoloration beginning about three inches above the knee and extending down to the toes. No pulsation could be felt nor was there any sign of skin circulation. Above this demarcation area the skin was hypersensitive. A diagnosis of embolus in the popliteal artery was made. She was immediately taken to the operating room and, under spinal anæsthesia, an incision was made on the posterior surface of her thigh down to the popliteal space. The artery was opened proximal to the knee-joint, and a clot about four inches long was dislodged from the femoral artery. This was followed by active bleeding, but further clots were felt down below the knee. These were removed. The wound in the artery was sutured. The following day the leg was still cold and blue, and an amputation was done in the upper third. Examination of the artery later showed a very marked obliterating endarteritis with organizing thrombus. The patient lived for thirty-five days following the amputation, and died of a myocarditis.

Comment.—A woman who had been treated by the medical side suddenly developed an embolus in her femoral artery. Clotting index, after the development of the embolus, was 4.1 and the antithrombin .46. This patient showed marked clotting powers, and the examination of the amputated leg showed changes in the intima of the artery, with obliterating endarteritis. During the operation for embolism it was noted that the blood clotted very readily in attempting to remove the embolus.

CASE II.—R. M., a woman, about fifty-five years of age, was admitted to the Surgical Service April 24, 1928, complaining of severe epigastric pain, distention, and anorexia at all times, aggravated by food. In the upper abdomen there were shooting pains to the right scapula. X-ray showed gall-stones and a deformity of the cap. Operation May 4, 1928. Two polyps were found in the antrum about an inch proximal to the pylorus. These were excised and the wound in the stomach closed. A small contracted gall-bladder containing a stone about two centimetres in diameter was removed and the cystic duct ligated. This patient had a rather high immediately-post-operative temperature for twenty-four hours, when it returned to 99°. On her sixth post-operative day she got out of bed and fell on her left arm. Shortly thereafter she had sudden pain in the left arm, with discoloration and coldness from the mid-portion

of the arm to the fingers. A pulse could be felt just below the pectoral muscle, but could not be traced down the arm beyond this area. Diagnosis of embolism was made, the patient taken to the operating room and an incision about a half inch long made in the brachial artery. A clot five inches long was removed, which was followed by active arterial bleeding. A small ureteral catheter was inserted upward and the lumen washed out so that very marked bleeding followed. The wound was then sutured. No pulse recurred at the wrist and the patient's condition failed gradually and she died the following day with high temperature and signs of myocardial failure.

Comment.—Woman operated on for polyp of the stomach and cholelithiasis. Her ante-operative examination showed a clotting index of 0.9 and an antithrombin of 1. The clotting index was high, but the antithrombin was normal. On her fifth post-operative day her clotting index was 1.9 (very high) and her antithrombin .7—both showing evidence of increased clotting tendency. The following night this patient got out of bed, fell on her left arm, and developed either a thrombus in the artery, or an embolus. In this case definite warning was exhibited by the blood examination that the patient had a tendency toward thrombosis.

Case III.—F. F., private patient of Dr. G. W. Roberts, was admitted to the Fifth Avenue Hospital July 25, 1928, with symptoms of abdominal pain and vomiting. At operation eighteen inches of gangrenous intestines with a very œdematous mesentery were found. Healthy intestine was found both proximal and distal to this gangrenous loop. The two healthy loops were sewed together and the gangrenous portion brought outside the abdominal wall. The wound was then closed and the gangrenous intestine covered with vaseline and rubber. Later operations were done for resection of end-to-end anastomosis. The patient died September 11, 1928, with symptoms suggesting an embolus in femoral artery.

Comment.—Patient admitted with mesenteric thrombosis; showed on admission clotting index of 1.9 and an antithrombin of .7. On two subsequent examinations the clotting index was 1.5 and 1.9 and the antithrombin .7 and .7. This patient eventually died with symptoms suggestive of *femoral embolism!* During the patient's entire stay in the hospital the clotting index was high and showed a tendency toward clotting.

Case IV.—Mrs. R. H. was operated on June 7, 1928, with a diagnosis of subacute appendicitis. The appendix, which was found to be enlarged, with very dilated blood-vessels and thickened wall, and bound down by very firm adhesions, was removed. On her ninth post-operative day she had a sudden attack of pain in her left chest, cough and bloody sputum. Her X-rays showed cloudiness over the left lower lobe. The symptomatology was very suggestive of pulmonary embolus. Two days after her discharge from the hospital, on her thirtieth post-operative day, she developed an acute femoral phlebitis of the left leg, with a temperature of 103°, with marked swelling and coldness of the leg. Two days later forty cubic centimetres of .5 per cent. of gentian violet was injected intravenously. The pain ceased in twenty-four hours. Following this her convalescence was slow, but uneventful.

Comment.—On her ninth post-operative day she had symptoms suggesting pulmonary embolus, although the X-ray diagnosis was pleurisy. The day after the symptoms in the chest the clotting index was 1.6 and the antithrombin .8, showing a marked clotting tendency. On the patient's thirtieth

post-operative day she developed an acute femoral phlebitis of the left leg, with a temperature of 103°, swelling and coldness.

CASE V.—Mrs. C. R., thirty-six years of age, was admitted to the Fifth Avenue Hospital November 12, 1928. Diagnosis of lacerated cervix and perineum, with retroversion. Operation: Repair of perineum and cervix and shortening of the round ligaments, with appendectomy. She ran a slight elevation of temperature for ten days post-operatively. On her twelfth day she had an elevation of temperature to 101°, and swelling, pain and coldness in the left thigh. The following day she was given an injection of 40 cubic centimetres of .5 per cent. gentian violet intravenously. There was a gradual subsidence of her temperature, so that it was normal after her nineteenth post-operative day, and she was discharged on her twenty-ninth day.

Comment.—The patient developed a left phlebitis in her femoral vein on her eleventh post-operative day. Her blood examinations, on her third and fifth pre-operative days, were negative for clotting tendencies. Examination after development of the phlebitis showed a clotting index of 1.4 and an antithrombin of .8. This patient developed a thrombus five days after her third routine examination. It is possible if a subsequent examination had been done two or three days before the development of the phlebitis, changes in the clotting time might have been observed.

CASE VI.—Mrs. J. B., forty-eight years of age, was admitted to the Fifth Avenue Hospital November 25, 1928. Diagnosis on admission was thrombosis of right brachial vein. Patient is a teacher, and was taking in receipts at the door of a school bazaar on the day before illness. During most of the afternoon she had sat in a low chair with the right arm resting on the edge of a table. Patient had been well physically up to this time, but very tired. Woke up early the following morning with a dull ache in right arm and, on getting up, found that arm was swollen, and became purple on hanging it down. At no time did patient have temperature or rise in white count.

Comment.—A woman who, with the slightest amount of trauma—merely resting her arm on a desk—developed a thrombosis of the brachial vein. On admission to the hospital her clotting time was 1, antithrombin .8. After being placed on a bleeding diet, six days later her clotting index was .5 and antithrombin 1, which were normal. This patient apparently had the clotting elements decreased in her blood by dietary measures. Further check-up on February 7, 1929, showed index .16 and antithrombin 1.5. Patient had not added protein to diet as advised, for fear of another accident.

CASE VII.—B., thirty-five years of age. Quite an obese woman who had suddenly developed painful swelling over a series of anterior lateral radicals *of* the internal saphenous vein. On examination there was a red area of skin about five inches long by two inches wide through which could be felt a hardened, indurated vein. There was no history of previous trauma or operation. Patient treated by elevation, rest in bed and diet.

Comment.—A woman without previous trauma or operation developed phlebitis. Her blood picture at the height of phlebitis showed a clotting index of 1.8 and an antithrombin of .8.

CASE VIII.—H. F., a woman, twenty-seven years of age, was admitted to the Fifth Avenue Hospital October 29, 1928, complaining of symptoms suggesting cholecystitis,

and also complaining of marked stomatitis, with skin lesions of the dorsum of both hands suggesting pellagra. She was placed on a high protein diet and discharged to the Out-Patient Department. She was readmitted to the hospital on December 11, 1928, with swelling and pain of both thighs and calves, and a diagnosis was made of double iliac thrombosis. Treated by rest in bed, diet, and elevation of the extremities.

Comment.—This patient on her first admission showed a high clotting index and low antithrombin. She was then placed on a high protein diet and readmitted to the hospital three weeks after discharge, with a bilateral iliac thrombosis. At her first admission her clotting index was .7 and her antithrombin .7. At her second admission her clotting index was 2, antithrombin .7. On discharge from the hospital, after being placed on a vegetable diet, her index had decreased to 1 and her antithrombin raised to .8. It would seem that this patient had a definite high clotting index, and with the administration of a high protein diet developed a double thrombosis.

CASE IX.—Mrs. S. D., thirty-four years of age, was admitted to the Fifth Avenue Hospital November 22, 1928, with symptoms of left adnexal disease. She was operated on November 24, 1928. Her left ovary was about four times normal in size, polycystic, and the left tube was occluded. The left tube and ovary and appendix were removed. On her eleventh day post-operative she developed a right femoral phlebitis. She was given 50 cubic centimetres of a .5 per cent. solution of gentian violet intravenously. The pain in the leg subsided and she was discharged from the hospital on her forty-sixth post-operative day, having had a normal temperature for three weeks. At this time there was no swelling of the leg. No examination had been done on this patient previous to the development of her phlebitis. At the time of her phlebitis her clotting index was 0.9 and her antithrombin .8.

CASE X.—L., a woman, twenty-five years of age, who had been a patient of the obstetrical department of the Fifth Avenue Hospital, where she had had a normal delivery. Five days after her return home she developed a left femoral phlebitis. Examination of the blood taken at her home showed a clotting index of 1.2 and antithrombin of .8.

CASE XI.—I. L., fifty-seven years of age, was admitted to the Fifth Avenue Hospital November 6, 1928, and operated on November 8, 1928, cholecystectomy, for cholecystitis and cholelithiasis, and appendectomy for chronic appendicitis. On his first post-operative day the patient developed a massive collapse of his right lung. This was treated by turning the patient on his well side and giving him a sharp slap in the back over the affected lung. He immediately had a coughing spell and coughed up several large masses of thick, yellow, tenacious sputum. Following this his temperature subsided. He developed a hæmatoma in his wound, which was opened on his sixth post-operative day, evacuating about half an ounce of old clotted blood. He left the hospital at the end of three weeks. Three days after his return home he had an attack of pain and swelling in his right leg. The leg was cold and swollen, and gave evidence of a phlebitis. A blood test, taken at his home, revealed a clotting index of 0.5, with antithrombin 0.8. He was treated by rest in bed and elevation of the leg. This was a private patient who had no examination of his blood before the development of a phlebitis. The clotting index of 0.5 was normal, but his antithrombin 0.8, showed a diminution and a tendency toward clotting.

All of the above cases had high blood-clotting factors as given by the blood-clotting index or the antithrombin index. In addition to these cases we have had sixty-five patients (a percentage of 33 per cent. of all cases

examined) who have had high blood indices, but who have not developed demonstrable thrombosis. If antithrombin is used as the index there have been thirty-six cases (18 per cent. of all cases) who are included in this danger group.

In reviewing the histories of these cases we find that many of them have had prolonged post-operative temperatures. There are also included most of our post-operative complications, such as wound infections, post-operative hæmatomas, or where there has been considerable tissue trauma. We believe, therefore, that a certain number of this group may have had deep thrombosis or are potential thrombosis formers.

The following group of cases have shown higher indices than the general run of surgical cases:

TABLE VII

	Total cases examined	Elevated index	Per cent.	Diminished anti-thrombin	Per cent.
Appendices	29	9	31	7	24
Gall bladders	23	11	48	7	30
Hernias	12	4	33	4	33
Pelvic cases	48	15	31	8	17

In the statistical reports of the incidence of thrombosis and embolism from various clinics [10, 11] the four groups enumerated above present the greatest percentage of thrombosis and embolism.

GENERAL COMMENT

The study of the blood-clotting factors in thrombosis and embolism was undertaken because we felt there must be some factor in the blood of patients which predisposes toward clotting, in addition to the factors of trauma, infection, and the slowing of the blood-stream which are also present. We felt that to study this problem there must be taken routine examinations of patients' blood pre-operatively, and three and five days post-operatively, besides such other determinations as might be decided on. It was obviously impossible to prognosticate what patients might form thromboses before they were operated. Therefore it was necessary to make the routine examinations referred to in order to study the patient's normal and abnormal reactions to surgical procedures. During the course of this work eleven cases of thrombosis, phlebitis or embolism have come under our study. All of these had high blood-clotting factors. Obviously, some cases that were transferred to us from the medical department after the development of thrombosis had no previous examinations. In this series we have had certain disappointments and certain rays of hope. The disappointments have been that we have not as yet simplified the procedure so that it may be made a simple laboratory test, nor have we proved definitely that a patient's tendency toward clotting can be determined pre-operatively. We

feel that routine post-operative examinations may indicate to us a patient's tendency toward thrombosis.

The rays of hope resulted from the fact that all cases we have studied with this complication have shown a high index. Two of these cases, II and IV, have shown high indices before the development of phlebitis. Three cases, VI, VII and X, of phlebitis, not anteceded by operative trauma, showed markedly high indices during the active time of their disease. Case VIII, a patient presumably suffering from pellagra, was put on a high protein diet, and had, on first examination, elevated blood-clotting factors. Following her high protein diet she developed thrombosis of both her iliac veins. During this time her clotting factors were increased by diet. Wherever possible we believe that a bleeding diet should be instituted when the clotting factors are high. Obviously in some post-operative cases this is impossible. It may be that some drug, such as heparin, may be utilized to remedy this condition.

One case, V, showed normal clotting both ante-operative and at the last routine examination five days post-operative. On her eleventh post-operative day she developed a thrombosis. This case is disappointing in that at her last examination, five days before the development of her thrombosis, there was no evidence of it in her blood picture. After the development of her thrombosis an examination of her blood showed that her blood-clotting factors had increased.

We recognize that our series is too small to warrant didactic conclusions. We have observed, however, that, after the occurrence of thrombosis and embolism, the blood-clotting factors are high. In two cases we believe there has been a definite warning beforehand.

We propose to continue our studies in the hope of finding a single test, such as antithrombin, which may prove to be a satisfactory index of a patient's clotting tendencies. If so, we believe that this test may be so simplified that it could be done daily in post-operative cases as a routine measure. Any diminution of the antithrombin, we believe, should be an indication for the immediate institution, if possible, of a bleeding diet.

Calcium and phosphorus determinations were made on a small series (thirty-three cases), but the variations from normal were so slight that these examinations were discontinued.

ANIMAL EXPERIMENTATION

The following experiments were made on dogs for the purpose of ascertaining the parts played by anæsthesia, trauma, and infection, respectively, in raising the clotting factors of the blood. These experiments were performed through the courtesy of the Laboratory of Surgery at the College of Physicians and Surgeons, Columbia University. The results of these tests on a series of dogs showed their blood-clotting factors were identical with those obtained from patients. The first experiments consisted of anæsthetizing the dogs with ether for one-half hour, testing the blood before and after. The blood was taken by veni-puncture from a large superficial vein

running obliquely across the outer side of the hind leg. The chart shows a slight raise in the index after anæsthesia, with change appearing in the fibrinogen and platelet factors.

TABLE VIII

Tests Made on Blood Before and After One-half-hour Ether Anæsthesia

Dog		Prothrombin	Fibrinogen	Antithrombin	Platelets	Platelet Lysis	Index
No. 9949	before	1.11	0.64%	1.16	200,000		0.6
	after	1.26	0.84%	1.16	270,000		0.9
No. 9923	before	1.00	0.64%	1.00	380,000	49%	0.5
	after	1.00	0.60%	0.95	505,000	54%	0.6
No. 9924	before	1.00	0.48%	1.16	300,000	48%	0.4
	after	1.11	0.54%	1.00	350,000	60%	0.6
No. 9988	before	1.00	0.40%	1.16	200,000	40%	0.3
	after	1.00	0.48%	1.16	200,000	42%	0.4

TABLE IX

Tests Made on Blood Before and After Removal of Appendix Under Ether Anæsthesia

Dog		Prothrombin	Fibrinogen	Antithrombin	Platelets	Platelet Lysis	Index
No. 9986	before	1.00	0.46%	1.16	165,000	39%	0.4
	after	1.00	0.46%	1.16	290,000	34%	0.4
No. 9987	before	1.45	1.03%	0.91	125,000	32%	1.6
	after	1.45	1.03%	0.91	platelets	not done	1.6
No. 9949	before	2.33	1.03%	0.91	45,000	dog had distemper	2.5
	after	2.33	1.03%	0.91	40,000		2.5
No. 9923	before	1.00	0.54%	1.00	420,000	52%	0.5
	after	1.11	0.64%	0.95	495,000	57%	0.7
No. 9924	before	1.11	0.54%	1.16	285,000	46%	0.5
	after	1.26	0.74%	1.00	300,000	53%	0.9
No. 9988	before	1.00	0.40%	1.16	200,000	40%	0.3
	after	1.45	0.64%	0.91	200,000	50%	0.36

This experiment was then repeated on four dogs, but this time the appendix was removed during the half hour of anæsthesia. The results show that the trauma of such a procedure added practically nothing to the changes produced by anæsthesia alone.

Dog No. 9949 had distemper, which presumably accounted for the marked difference in his figures. The experiment was repeated again, but this time the gall-bladder was removed. The change in clotting factors was similar to those following the removal of the appendix.

After trying out these relatively normal procedures an attempt was made to reproduce acute appendicitis and acute cholecystitis. For this purpose three dogs were anæsthetized and the tips of the appendices were tied off. The blood was tested before and after operation. At the end of twenty-four hours the dogs were then anæsthetized, the wounds opened and the appendices removed. In cases of dogs No. 9996 and No. 9991 there was a marked rise in prothrombin, fibrinogen and platelets and a drop of antithrombin after the first operation. Microsections of the appendices removed showed gangrene. In the case of dog No. 9979 the clotting factors were high at the time of operation. The dog died within twenty-four hours after the procedure and autopsy showed gangrene of not only the appendix but also the cæcum and terminal ileum. We believe this to have been caused by tying off the appendix at the base instead of the tip in a dog whose clotting factors were high at the start.

TABLE X

Tests Made on Blood Before and After Tying off Appendix and Before and After Removing Same Appendix at End of Twenty-four Hours

Dog		Pro-thrombin	Fibrino-gen	Anti-thrombin	Platelets	Platelet Lysis	Index
1st operation No. 9996 2nd operation	before.....	1.26	0.84%	1.00	120,000	25%	1.0
	after.....	1.26	0.84%	1.00	140,000	29%	1.0
	before.....	1.45	0.94%	0.96	250,000	60%	1.4
	after.....	1.45	0.94%	0.95	255,000	62%	1.4
1st operation No. 9991 2nd operation	before.....	1.00	0.54%	1.00	140,000	36%	0.5
	after.....	1.00	0.64%	1.00	150,000	40%	0.6
	before.....	1.11	1.03%	0.95	270,000	44%	1.2
	after.....	1.11	1.03%	0.95	260,000	46%	1.2
1st operation No. 9979 2nd operation	before.....	1.26	1.03%	0.95	160,000	39%	1.3
	after.....	1.26	1.03%	0.95	200,000	50%	1.3
	before.....		dog died	within t	wenty-fou	r hours.	
	after.....						

On Table XI, presented below, are shown the results of our attempt to produce acute cholecystitis. In the case of dog No. 9923, the tip of the gall-bladder was tied off and a piece of gauze containing pus from an infected wound on a dog's leg was inserted in it and the opening sutured. After

twenty-four hours the wound was opened and the gall-bladder removed. The results of the two procedures showed a rise in the blood-clotting elements. (See table below.) Microsections of the gall-bladder, through the area ligated, showed acute cholecystitis.

The procedure on dog No. 9888 varied a little in that the cystic duct and artery were ligated and pus introduced into the whole bladder. The blood picture showed a greater rise in the blood-clotting factors and the sections showed both infection and gangrene of the bladder.

Dogs No. 9924 and No. 9991 had the tips of the gall-bladders tied off, but

TABLE XI

Tests Made on Blood Before and After Tying Off Tips of Gall-bladder and Before and After Removing Same Gall-bladder at End of Twenty-four Hours

Dog		Pro-thrombin	Fibrinogen	Anti-thrombin	Platelets	Platelet Lysis	Index
1st Operation No. 9923 2nd Operation	before	1.26	0.48%	1.00	235,000	49%	0.6
	after	1.45	0.48%	1.00	505,000	58%	0.7
	before	1.45	0.60%	0.91	270,000	60%	0.9
	after	1.26	0.60%	0.95	370,000	59%	0.8
1st Operation No. 9888 2nd Operation	before	1.11	0.54%	1.16	235,000		0.5
	after	1.45	0.54%	0.95	220,000		0.8
	before	1.45	0.79%	0.87	185,000		1.3
	after	2.33	0.84%	0.87	275,000	51%	2.3
1st Operation No. 9924 2nd Operation	before	1.26	0.69%	1.16	335,000	40%	0.8
	after	1.26	0.69%	1.16	310,000	37%	0.8
	before	1.26	0.64%	1.00	425,000	41%	0.8
	after	1.26	0.64%	1.00	450,000	40%	0.8
1st Operation No. 9991 2nd Operation	before	1.11	0.60%	1.00	165,000	39%	0.6
	after	1.11	0.64%	1.00	175,000	43%	0.7
	before	1.11	0.79%	0.95	195,000	38%	0.9
	after	1.11	0.79%	0.95	250,000	44%	0.9

no pus introduced into them. The first of these showed little or no change in the clotting factors, and microscopic sections revealed a congested mucous membrane. Apparently the ligature had not been drawn tightly enough to produce gangrene. The second case, however, showed gangrene, and the figures of the blood tests resembled the first two cases.

PRE-TONSILLECTOMY EVALUATION OF BLOOD-CLOTTING FUNCTION

Among the great number of patients undergoing tonsillectomy there is a group who are definite operative risks and present difficulties if operation is

performed. The clotting-time determination is no index of the clotting function and has been found non-conclusive in an exhaustive study by W. M. Hunt.[9] On the other hand there is another group whose blood-clotting times have been found increased and are suspected as bleeders. Clotting function tests of such patients have been found normal in a number of cases and have thus eliminated them from the category of bleeders.

TABLE XII

Pre-Tonsillectomy Analysis of Clotting Components in Suspected Bleeders

(From the Service of W. M. Hunt, Fifth Avenue Hospital)

Group 1.—Patients with Deficient Clotting Function

Name	Clotting time	Bleeding time	Prothrombin	Fibrinogen	Antithrombin	Platelets	Platelet disintegration	Clotting index	Remarks
S. I. S.	5′0″	4′0″	0.66	0.54%	1.57	250,000	24%	0.2	Hemophilia
D.	7′30″	2′30″	0.87	0.42%	1.08	195,000	21%	0.3	Hemophilia
B.	6′45″	2′0″	0.13	0.56%	6.8	300,000	10%	0.003	Hemophilia

TABLE XIII

Group 2.—Patients with Normal Clotting Function

Name	Clotting time	Bleeding time	Prothrombin	Fibrinogen	Antithrombin	Platelets	Platelet disintegration	Clotting index	Operation
K.	8′15″	2′30″	0.96	0.93%	0.96	180,000	28%	0.9	Tonsillectomy
R.	5′0″		1.38	0.74%	0.86	180,000	39%	1.0	Tonsillectomy
F.	4′0″	2′0″	1.38	0.59%	1.0	200,000	25%	0.8	Tonsillectomy

TABLE XIV

Group 3.—Nutritional Bleeders

Name	Date	Clotting time	Bleeding time	Prothrombin	Fibrinogen	Antithrombin	Platelets	Platelet Lysis	Index
H		6′45″	6′15″	0.6	0.60%	1.5	175,000	37%	0.1
		5′45″		0.93	0.64%	1.07	150,000	37%	0.3
		6′30″		0.93	0.60%	1.07	190,000	37%	0.4
B		4′30″		0.87	0.46%	1.25	240,000	62%	0.2
		8′0″		0.93	0.28%	1.25	210,000	52%	0.2

CASE DISCUSSION

Group 1.—Five patients appeared for an indicated tonsillectomy. The clotting times were normal, and yet the past histories revealed bleeding ten-

dencies from birth. The low percentage of platelet disintegration characterized such as hemophiles.

Group 2.—Four patients appeared for tonsillectomy with histories of having bled readily on bruising (F.), or having been denied operation at another hospital because of prolonged clotting time (K.), or having a family history of bleeders (R.). Clotting function determinations were normal and operation was uneventful in each case.

Group 3.—Four patients scheduled for tonsillectomy had histories of bleeding readily. Clotting function studies showed that previous difficulties in arrestive bleeding in these patients were due to clotting deficiencies correctable by a clotting diet (Vide chapter on Dietary Treatment of Hæmorrhagic Diseases).

Case H. showed an index of 0.1 which on a clotting diet rose to 0.3 and later to 0.4. The resulting status of Mrs. H. became more favorable for operation. Case B., an interne at the hospital, had an index of 0.2. His tendency to bleeding was associated with his vegetarian dietary. Doctor B. was advised to adopt a clotting diet, but he failed to keep it up and after operation bled periodically for a week. The clotting index remained 0.2 on a persistent vegetarian régime.

PRENATAL PREVENTION OF POTENTIAL HÆMORRHAGIC DISEASE OF THE NEW-BORN

True melæna neonatorum is a distinct entity when hæmorrhage from the gastro-intestinal tract and a progressively prolonged clotting time of the blood dominate the entire disease picture of a new-born infant. This disease differs from other hæmorrhagic "diatheses" of the new-born secondary to sepsis, thrombocystopenic purpura, congenital lues, congenital anomalies of the viscera and tumors of the abdomen.

The clotting time of true melæna is not conclusive for characterizing the hæmorrhagic tendency of a new-born infant. At birth the clotting time may be normal, though spontaneous bleedings occur, and the clotting time may be delayed, though there be no hæmorrhage. The quantitative determination of the clotting components of the blood indicates the nature of its clotting deficiency and hence the hæmorrhagic status of the infant. The blood deficiency of melæna neonatorum is characterized by a marked decrease in the prothombin content of the infant's blood.

The hereditary aspect of abnormal bleeding has been restricted to hemophiliacs. Other forms of hæmorrhagic disorders may be conveyed from parent to offspring and the transmission not be sex-linked; yet no studies of such disturbances have been made.

The blood of the fœtus is in equilibrium with the maternal blood. Any deviation in the concentration of the clotting components should be manifest in the maternal blood studied early in the course of the pregnancy. The evaluation of the blood-clotting function of maternal blood thus offers a basis of prediction of potential hæmorrhagic disease developing in utero. Such an early diagnosis is more favorable for prenatal preventive therapy.

CASE—(Patient of Doctor Tritsch). Mrs. T. N. had five pregnancies, first four of which terminated in death of new-borns with hæmorrhagic disease in three and possibly in the fourth. First baby, a girl, died about eight hours after birth; second, a boy, was still-born following forceps delivery; third, a girl, died within three hours after birth; fourth, a girl, died twenty-two days of age; the present fifth, a boy, is living and normal.

The mother and father were negative for lues, focal infections, etc. During the fourth pregnancy the mother was toxic and was maintained on a low protein diet. The family history was negative, from the standpoint of hæmorrhagic disturbances.

TABLE XV

The Clotting Factors of Mrs. T. N.'s Blood

Date	Clotting time	Bleeding time	Pro-thrombin	Fibrino-gen	Anti-thrombin	Platelets	Lysis Percent	Index
Dec. '27.			0.31	0.38	1.5	154,000	—	0.071
Mar. '28.	6'15" . 5'15"	4'45"	0.35	0.75	1.4	175,000	37	0.2
May '28.	2'30" . 1'45"	1'30"	1.12	0.79	0.75	265,000	68	1.3
			The Clotting Factors of Mr. N.'s Blood					
May '28.	3'30" . 1'30"	2'00"	0.98	0.46	1.0	255,000	70	0.4
			The Clotting Factors of Baby N.					
Aug. '28.	2'15" . 1'30"	1'30"	1.0	0.47	1.0	380,000	60	0.5

The blood of Mrs. T. N. examined the second month of pregnancy showed a somewhat prolonged clotting time by tissue and venous puncture, respectively. The prothrombin index was markedly low, 0.31 (normal 1.0), the characteristic finding in true melæna neonatorum. The fibrinogen content was low, 0.38 per cent. (normal 0.6 per cent). The antithrombin index was somewhat elevated, 1.5, (normal 1.0). The platelets were low, normal 154,000. Hence, Mrs. T. N.'s blood at the second month of pregnancy was poor in clotting function and specifically low in prothrombin content, the characterizing deficiency factor in the blood of true melæna. The father's blood was normal.

The treatment of Mrs. T. N. consisted in an analysis of her nutritional habits in order that her corrected food intake may be balanced and adequate and particularly high in varied proteins (six grams per kilo of body weight) and varied lipins. The visceral organs were given because of their protein phospholipin content in this order: lung, kidney, testes, brain, heart, pancreas, liver. The acid-forming proteins were neutralized by base-forming fruits and vegetables. Excess of basic salts are requisite for a positive calcium balance as well as for their favorable effect on prenatal development.

DIETARY TREATMENT OF HÆMORRHAGIC DISEASES

The substances involved in the normal clotting of blood when shed are found in relatively constant amounts. Deviations from such values favor either bleeding or thrombosing depending on a decrease or an increase in the concentrations of these substances in the blood.

The chemical nature of the clotting components has been established as lipins for the platelets originating in the bone-marrow, and globulins for the prothrombin and fibrinogen synthesized in the liver.

Lipins and globulins are the source of the blood-clotting substances, initially arising from the daily dietary. This nutritional basis for the composition of blood in clotting substances led us to a dietary treatment for certain hæmorrhagic diseases.

The blood problems studied constituted two large groups—bleeders whose clotting substances were decreased in concentration and those tending to thrombose, in whom the clotting substances were increased in concentration in the patient's blood.

Bleeders found deficient in fibrinogen or prothrombin were maintained on an acid-forming diet high in globulins—a protein intake of about five grams per kilo of body weight.

Bleeders found deficient in platelets were maintained on an acid-forming dietary high in unsaturated lipins, constituting two-thirds of the caloric intake.

Patients whose clotting function index were found to be high were maintained on a base-forming dietary consisting of 0.50 gram kilo body weight, fat as contained in the natural food without addition and increased fluid intake.

Analyses of bleeding diets to decrease clotting function and clotting diets to increase clotting functions are given below.

TABLE XVI

Results with Clotting Diet

Name	Diagnosis	Date	Clotting time	Bleeding time	Prothrombin	Fibrinogen	Antithrombin	Platelets	Platelet disintegration	Clotting Index	Remarks
						Per cent.			Per cent.		
M	Chronic appendix . . .	7/30	5′30″	1′0″	1.0	0.28	1.07	460,000	48	0.3	
		8/1	5′30″	1′0″	0.93	0.37	1.0	240,000	44	0.3	
		8/7	3′30″	1′30″	0.93	0.60	1.0	330,000	54	0.6	
		8/9	3′30″	1′30″	0.87	0.54	1.0	225,000	42	0.5	
A	Hypertrophied tonsils	9/17	6′45″		0.60	0.60	1.5	175,000	37	0.2	
		10/16	5′45″		0.93	0.64	1.07	150,000	37	0.5	
		10/31	6′30″		0.93	0.60	1.07	190,000	31	0.5	
N	Children bleeders . .	3/10	6′15″	4′45″	0.39	0.75	1.4	175,000	37	0.2	
		5/21	2′30″	1′30″	1.37	0.79	0.82	265,000	66	1.3	
S		8/30	4′0″	2′30″	1.54	0.54	0.82	115,000	12	1.0	
		9/17	4′0″	2′30″	1.54	0.69	0.82	205,000	60	1.5	
		10/8	4′0″	2′30″	1.54	0.69	0.82	260,000	61	2.0	

CASE DISCUSSIONS

CASE M. was admitted for operation and found to have a low clotting index (0.3) as the result of low fibrinogen. M. was put on a clotting diet which doubled the blood fibrinogen and hence brought the clotting index to normal.

CASE H. was advised a tonsillectomy, but a long-standing bleeding history made H. an operative risk. The prothrombin was low (0.6) and the antithrombin high (1.5). Diet brought the prothrombin and antithrombin to normal with a resultant normal clotting index.

CASE N. was studied in the Out-Patient Department because of purpuric spots and prolonged bleeding when bruised. N. showed a low prothrombin (0.39), a high antithrombin (1.4), and low platelets. A clotting diet readily brought the blood to a high normal clotting function.

CASE S., a girl, thirteen years of age, had a persistent metrorrhagia for four months since the onset of menstruation. On a clotting diet, the clotting index rose from 0.1 to 2.0 with a simultaneous cessation of the bleeding.

CASE M., a physician's boy, nine years of age, had a typical thrombocytopenic purpura. The boy also had a chronic eczema since the sixth month of life and was maintained on an approximate fat-free diet as part of the therapy for the eczema. With the onset of purpura and the platelets decreasing to less than 50,000 splenectomy was advised. A clotting diet with two-thirds of the calories in fat raised the platelets to 340,000. The boy has been free from purpura or eczema for fifteen months.

TABLE XVII

Results with Bleeding Diet

Name	Diagnosis	Date	Clotting time	Bleeding time	Prothrombin	Fibrinogen	Antithrombin	Platelets	Platelet disintegration	Clotting	
						Per cent.			Per cent.		
W.	Partial nephrectomy for double pelvis of kidney	5/11	4′15″	1′30″	1.38	1.12	1.00	380,000	65	1.5	
		5/14	4′30″	2′0″	1.00	0.56	1.04	370,000	60	0.5	
		5/21	3′15″	1′30″	1.54	0.69	1.04	420,000	66	1.1	
F.	Cystic ovary, chronic appendix	7/26	3′30″	2′0″	0.93	0.56	1.25	500,000	49	0.4	
		8/2	3′15″	2′0″	1.38	0.75	1.00	360,000	59	1.0	
		8/4	4′0″	2′0″	1.38	1.03	0.75	350,000	65	1.8	
		8/7	4′0″	2′0″	0.93	0.46	1.07	265,000	47	0.4	

CASE W., a woman, was admitted for removal of an extra lobe of the left kidney. Five days post-operative her clotting index was found to be high and she was put on a bleeding diet. In three days' time the index went from 1.5 down to 0.5. She was then put back on a diet containing protein, and after a week her blood index had risen again to 1.1.

CASE F. was operated on for cystic ovary and chronic appendix. Pre-operative index was 0.4. Following the operation her index rose to 1.0 and 1.8. After three days on a bleeding diet her index dropped to 0.4 again.

DIETARY STUDIES ON ANIMALS

Studies were made on four dogs of the relations between diet and the blood-clotting factors. The animals were maintained on a bleeding diet for forty-eight hours. Blood determination at the end of this period showed a decrease in the clotting factors and index. They were then fed a clotting diet for forty-eight hours, with a definite rise over normal of the clotting factors and index. The details are given in table XVIII.

CONCLUSIONS

1. The present studies were undertaken to determine the reaction of the blood-clotting factors to surgical procedures, and to surgical diseases, such as thrombosis and embolism and certain bleeding diseases.

2. The methods of determination of the substances involved in blood coagulation are presented, *i.e.*, prothrombin, fibrinogen, antithrombin, platelets, and the degree of platelet lysis.

TABLE XVIII

Tests Made on Blood After (1) Normal Diet, (2) After Forty-eight Hours on a Carbohydrate and Vegetable Diet, (3) After Forty-eight Hours on a Visceral Diet

Dog		Pro-thrombin	Fibrin-ogen	Anti-thrombin	Platelets	Index
No. 9949	Normal diet	1.11	0.64%	1.16	200,000	0.6
	Carbohydrate and Vegetable diet	1.11	0.64%	1.16	200,000	0.6
	Protein diet	1.45	1.12%	0.95	250,000	1.7
No. 9923	Normal diet	1.00	0.54%	1.00	400,000	0.5
	Carbohydrate and Vegetable diet	0.74	0.54%	1.16	220,000	0.3
	Protein diet	1.00	0.64%	0.95	300,000	0.7
No. 9924	Normal diet	1.11	0.64%	1.16	220,000	0.6
	Carbohydrate and Vegetable diet	1.11	0.28%	1.00	135,000	0.3
	Protein diet	1.26	0.69%	1.00	210,000	0.9
No. 9888	Normal diet	1.00	0.40%	1.16	200,000	0.3
	Carbohydrate and Vegetable diet	1.00	0.40%	1.16	325,000	0.3
	Protein diet	1.11	0.64%	0.95	330,000	0.7

3. The index of blood-clotting function is a value calculated from the composition of the clotting components.

4. A classification of diseases in which the blood-clotting function is altered is given.

5. Eleven cases of proven thrombosis, phlebitis or embolism have been studied. All of these cases had a high clotting index and a low antithrombin. In addition a small percentage of post-operative cases, not proven to have thrombosis or embolism, showed high clotting factors.

6. Animal experiments have shown an increase in the clotting factors following post-operative infection and gangrene, and a lesser increase following ether anæsthesia.

7. Pre-tonsillectomy studies of the clotting function are given for three groups of cases (*a*) with deficient clotting function; (*b*) with normal clotting function, previously suspected as bleeders; (*c*) nutritional bleeders treated by diet.

8. The prenatal prevention of potential hæmorrhagic disease of the new-born is given with a case report of a woman who gave birth to four previous infants with true melæna neonatorum.

9. The dietary treatment of hæmorrhagic diseases is presented. Analyses of diets are given for increasing clotting function (clotting diets) and for decreasing clotting function (bleeding diets). Animal experiments show that the tendencies to bleed or clot are definitely influenced by diet.

Case reports are presented with results obtained on bleeding and clotting diets.

10. This is a preliminary report. Studies are being continued.

APPENDIX

Diet to Increase Clotting Function of the Blood

Calories 1000. Protein 8 gm. per kilo. Fat ⅔ of calories. Water low. Acid high.

	P	C	F	H_2O
	20 per cent.	12 per cent.	68 per cent.	
CHILD	20 gm.	33 gm.	75 gm.	435 c.c.

Food	Measurements	Protein	Carbon	Fat	Calcium	Acid	Base	Vitamin	H_2O
Breakfast:									
Stewed fruit (fresh)	4 tbsp.	.2	3.8	.2	18.3		2.01	ABC	18.
Evaporated milk	2 tbsp.	3.8	4.5	3.7	66.8		.7	ABCDEG	27.
Egg	1	6.7	...	5.3	76.8	5.55		ABDEG	37.
Bacon	2 strips	2.1	...	13.0	129.5	*		AB	4.
Whole wheat bread	1 slice	.9	5.2	.1	25.9	.3		AB	4.
Dinner:									
Potato	4 tbsp.	1.0	8.4	....	38.5		2.8	ABC	30.
Butter	2 pats	.2	...	17.	158.9	....	.....	ADG	1.
Liver		19.0	...	5.3	123.7	*			73.
Milk	½ glass	3.3	5.	4.0	71.2		1.81	ABCDEG	87.
Supper:									
Brain		8.8	...	9.3	118.9	*			81.
Spinach	Small serving	.8	2.3	.2	14.6		16.20	ABC	54.
Egg yolk	1	3.1	...	6.7	75.	5.33		ABD	1.
Bone-marrow		.2	...	9.2	83.6		*		
Stewed fruit (fresh)	4 tbsp.	.2	3.8	.2	18.3		2.01	ABC	18.
		13.1	6.1	25.6	310.4				435.

Diets to Increase Clotting Function of the Blood

Calories 1000. Protein 5.2 per kilo. Fat ½ of calories. Water low. Acid reaction.

	P	C	F	H_2O
	25 per cent.	25 per cent.	50 per cent.	
	61 gm.	64 gm.	55 gm.	565 c.c.

Food	Measurements	Protein	Carbon	Fat	Calcium	Acid	Base	Vitamin	H_2O
Breakfast:									
Stewed fruit	2 tbsp.	.4	6.6	.2	30.6		1.6	ABC	17.
Eggs	2 yolks	6.2	....	13.4	150.	10.7		ABD	18.
Bacon	1 strip	1.1	....	6.5	65.	.5		AB	2.
Toast	1 slice	.9	5.2	.1	25.9	.3		AB	5.
Milk	1 cup	7.8	12.	9.6	170.8	....	5.5	ABCE	208.
Dinner:									
Potatoes	1 small	1.1	9.5	....	43.4	....	3.	ABC	34.
Butter	1 pat	.1	....	4.3	40.1	....	....	AB	4.
Beef, scraped	2 tbsp.	9.	....	1.1	48.	5.		ABC	28.
Cream cheese	¼ cake	5.2	.5	6.7	83.	1.1		AB	7.
Stewed fruit	2 tbsp.	.4	6.6	.2	30.6		1.6	ABC	17.
Supper:									
Asparagus	Serving	.8	2.3	.2	14.6		.5	ABC	54.
Cauliflower	Serving	.8	2.3	.2	14.6		3.1	AB	55.
Liver	Serving	22.4	2.4	4.2	120.8	*		ABC	69.
Bread (stale)	1 slice	.9	5.2	.1	25.9	.3		AB	5.
Butter	1 pat	.1	....	4.3	40.1	....	....	AB	4.
Custard	⅓ cup	4.3	11.	4.3	100.		3.2	ABCDEG	38.
		61.5	63.6	55.4	1003.	17.9	18.5		

Diets to Increase Clotting Function of the Blood

Calories 1000. Protein 5.2 per kilo. Fat ½ of calories. Water low. Acid reaction.

	31 per cent. P	35 per cent. C	34 per cent. F	H_2O
CHILD—12 kilo.	78 gm.	88 gm.	37 gm.	708 c.c.

Food	Measurements	Protein	Carbon	Fat	Calcium	Acid	Base	Vitamin	H O
Breakfast:									
Fruit (stewed)	4 tbsp.	.2	8.5	.3	38.5	....	2.2	ABC	51.
Sugar	Scant tbsp.		5.	....	20.5	....	....	....	...
Eggs	2	13.4	....	10.5	152.6	11.1		ABD	73.
Rice (boiled)	2 tbsp.	.8	7.3	....	33.2	2.8		B	22.
Milk	1 cup	7.8	12.	9.6	170.8		5.5	ABCE	208.
Toast	1 slice	.9	5.2	.1	25.9	.7		AB	5.
Dinner:									
Green Vegetables:									
Cauliflower	4 tbsp.	.8	2.3	.2	14.6		3.2	ABC	55.
Asparagus	4 tbsp.	.8	2.3	.2	14.6		.5	ABC	56.
Beef (scraped)	Serving	23.	....	2.5	114.5	13.9		AB	70.
Bread (stale)	1 slice	.9	5.2	.1	25.9	.7		AB	5.
Custard	⅓ cup	4.3	11.	4.3	100.		3.2	ABCE	
Liver	Serving	22.4	2.4	4.2	120.8	*		ABC	69.
Potatoes	3 tbsp.	1.1	9.5	....	43.4		1.5	ABC	34.
Butter	1 pat	.1	....	4.3	40.1	....	....	AB	4.
Bread	1 slice	.9	5.2	.1	25.9	.7		AB	5.
Fruit (stewed)	4 tbsp.	.3	7.6	.2	34.3		.9	ABC	51.
Sugar	Scant tbsp.	....	5.	....	20.5	....	....	....	...
		77.7	88.5	36.6	996.2	29.9	17.0	ABCDE	708.

* Acid—No analyses.

Equivalents	Wt. in gm.	Pro. gm.	Fat gm.
Meat:			
Beef, scraped	100	23.	2.5
Brain	100	8.8	9.3
Caviar	100	30.	7.6
Cheese (full cream)	100	25.9	33.7
Chicken (white meat)	100	17.6	7.6
Egg yolk	100	15.7	33.3
Fish (halibut)	100	18.6	5.2
Kidney	100	13.7	1.9
Liver (chicken)	100	22.4	4.2
Liver (veal)	100	19.	5.3
Lungs	100	16.4	3.2
Sweetbread	100	16.8	12.1
Tongue	100	18.9	9.2
Fat:			
Bacon	100	10.5	64.8
Bone-marrow	100	2.2	98.8
Butter	100	1.	85.
Chicken fat	100		100.
Cod-liver oil	100		100.
Goose fat	100		
Nut and Nut Products:			
Almonds	100	21.	54.9
Brazil nuts	100	17.	66.8
Peanuts	100	25.8	38.6
Peanut butter	100	29.3	17.1
Vegetable Food:			
Beans, dry	100	22.5	1.8
Beans, green	100	4.7	3.8
Beans, lima, dry	100	18.	1.5
Beans, lima, green	100	3.2	.3
Lentils, dry	100	25.7	1.0
Peas, dry	100	24.6	1.0
Peas, green	100	7.0	.5

Diet to Increase Clotting Function of the Blood

Calories 2000. Protein 5 gm. per kilo. Fat ⅔ calories. Water low. Acid reaction.

	18 per cent. P	16 per cent. C	66 per cent. F	H_2O
ADULT	90 gm.	80 gm.	148 gm.	817 c.c.

Food	Measurements	Protein	Carbon	Fat	Calcium	Acid	Base	Vitamin	H_2O
Breakfast:									
Stewed fruit (dry)	4 tbsp.	.9	20.7	.4	90.	....	2.01	ABC	18.
Cooked cereal...	6 tbsp.	2.5	10.	1.1	59.9	1.9	....	ABE	1.
Bacon.....	3 strips	3.2	....	19.4	174.6	?		AB	6.
Liver.....	Serving	23.8	....	6.6	154.6	?			91.
Coffee.....	.....	....	....						
Cream 20 per cent	¼ cup	1.5	2.7	11.1	116.7	....	....	ABCE	44.
Dinner:									
Peas.....		3.6	9.8	.2	55.4		1.3	ABCDE	85.
Celery.....		1.3	3.9	.3	23.5		7.8	ABC	93.
Butter.....	1 pat			8.5	76.5			ABG	1.
Sweetbread.....	Serving	25.2	.....	18.1	263.7	....	....		105.
Chicken fat.....	2 tbsp.			15.0	135.0				
Lettuce.....		.6	1.5	.2	10.2		3.7	ABCDEG	47.
Oil.....				10.	90.				
Stewed fruit....	⅓ cup	.6	10.2	.4	46.8		5.4	ABC	64.
Supper:									
Whole wheat bread.....	1 slice	.9	5.2	.1	25.9	.3		AB	3.
String beans....		1.3	3.9	.3	24.1		5.4	ABC	93.
Butter.....	1½ pats	20.6	.6	12.8	115.2				
Kidney.....		20.6	.6	2.9	110.9	?		ADG	94.
Bone-marrow...		.5		18.6	169.4				
Stewed fruit (fresh).....		.6	10.2	.4	48.		3.	ABC	64.
Nut meats (Brazil).....		5.1	2.1	20.	208.8				1.
		92.2	80.8	146.4	1999.2				817.

Diets to Increase Clotting Function of the Blood

Calories 2000. Protein 2.6 gm. per kilo. Fat ⅓ calories. Water low. Acid reaction.

	36 per cent. P	27 per cent. C	37 per cent. F	H_2O
ADULT—70 kilo.	178 gm.	135 gm.	82 gm.	1242 c.c.

Food	Measurements	Protein	Carbon	Fat	Calcium	Acid	Base	Vitamin	H_2O
Breakfast:									
Stewed fruit....	Serving	.8	20.1	.6	87.1		5.4	ABC	127.
Eggs.....	2	13.4	.....	10.5	152.6	11.1		ABDEG	74.
Liver (chicken)..	Serving	22.4	2.4	4.2	120.8	*		ABEG	69.
Toasts.....	2 slices	1.9	10.4	.2	52.3	.6		AB	10.
Milk.....	1 cup	7.9	12.	9.6	170.8		5.5	ABCDEG	208.
Dinner:									
Lentil soup: Milk.....	1 cup	7.9	12.	9.6	170.8		5.5	ABCDEG	208.
Lentils.....	⅓ cup	13.	30.	.5	176.5	2.5		.....	4.
Chicken (white meat).....	Serving	35.2	.....	15.2	285.6	21.4		ABEG	120.
Vegetables.....	Serving	.8	2.3	.2	14.6		6.5	ABCDEG	57.
Bread.....	2 slices	1.7	10.4	.2	52.3	.6		AB	10.
Supper:									
Caviar.....	1 tbsp.	3.	.7	2.	32.8	*			4.
Celery.....	Serving	.7	2.	.2	12.9		3.9	ABC	48.
Cream cheese...	½ cake	10.	1.	13.5	165.5	2.2		AB	14.
Saltines.....	2	1.1	6.9	1.3	44.9	.8			1.
Beef (broiled)...	Serving	56.6	.2	13.5	348.7	33.4		ABEG	168.
Potato.....	Small	2.	16.7	.1	77.6		5.6	ABC	57.
Stewed fruit....	⅓ cup	.3	10.6	.4	48.4		2.8	ABC	63.
		178.9	137.7	81.8	2014.2	72.6	35.2		1242.

Diets to Decrease Clotting Function of the Blood

Calories 1000. Protein ¼ gm. per kilo. Fat only in natural foods. Basic reaction. Water high.

	7 per cent. P	70 per cent. C	23 per cent. F	H_2O
CHILD—12 kilo.	17 gm.	173 gm.	25 gm.	770 c.c.

Food	Measurements	Protein	Carbon	Fat	Calcium	Acid	Base	Vitamin	H_2O
Breakfast:									
Stewed fruit (fresh)	5 tbsp.	.8	12.7	.5	60.		3.7	ABC	85.
Cereal (cooked)	3 tbsp.	1.3	5.	.5	30.	1.		ABCE	7.
Honey	1 tbsp.	.1	24.4		100.			AB	5.
Milk	1 cup	7.9	12.	9.6	170.8		4.3	ABCDEG	208.
Dinner:									
Green Vegetables:									
Spinach	2 tbsp.	.4	1.2	.1	7.5		8.	ABC	28.
Cauliflower	2 tbsp.	.4	1.2	.1	7.5		1.6	AB	28.
Tomatoes	1 small	.4	1.2	.1	7.5		1.4	ABC	24.
Butter	¾ pat	.1	....	6.4	58.8	.....	...	ABDG	1.
Potatoes	1 small	2.5	21.	.1	96.9		7.	ABC	76.
Stewed fruit (fresh)	5 tbsp.	.8	12.7	.4	60.		3.7	ABC	85.
Honey	1 tbsp.	.1	24.4	...	100.	.....	...	AB	5.
Supper:									
Green Vegetables:									
Asparagus	2 tbsp.	.4	1.2	.1	7.5		.2	B	28.
Carrots	2 tbsp.	.6	2.7	.1	14.5		3.2	ABC	26.
Cabbage	2 tbsp.	.4	1.2	.1	7.5		1.8	ABC	27.
Butter	¼ pat	.1	....	6.4	58.8	.....	...	ABDG	1.
Rice	¼ cup	1.7	14.6	.1	67.8	5.		B	44.
Fruit	5 tbsp.	.8	12.7	.4	60.		3.7	ABC	85.
Honey	1 tbsp.	.1	24.4	...	100.	.....	...	AB	5.

Diets to Decrease Clotting Function of the Blood

Calories 2000. Protein .25 per kilo. Fat low. Basic reactions. Water high.

	5 per cent. P	75 per cent. C	20 per cent. F	H_2O
ADULT—70 kilo.	18 gm.	360 gm.	47 gm.	1176 cc.

Food	Measurements	Protein	Carbon	Fat	Calcium	Acid	Base	Vitamin	H_2O
Breakfast:									
Fresh fruit	Generous serving	2.	31.8	1.2	150.		14.	ABC	217.
Honey	2 tbsp.	.2	48.7	....	200.	...	....	AB	11.
Cereal	6 tbsp.	2.5	10.	1.1	61.	2.		ABCE	14.
Cream	2 tbsp.	.8	1.4	5.5	60.3	.....	....	ABCE	22.
Coffee and sugar	2 tbsp.	....	25.	....	100.	.....	....	.....	....
Dinner:									
Spinach	Serving	1.3	3.9	.3	24.		27.	ABCG	92.
Celery	Small serving	.7	2.	.2	12.9		3.9	ABC	48.
Potato	Small	1.9	15.7	.1	73.1		5.25	ABC	59.
Butter	2 pats	....		17.	158.	.....	....	ABDG	2.
Fruit	Generous serving	2.	31.8	1.2	150.		14.	ABC	217.
Honey	2 tbsp.	.2	48.7	....	200.	.....	....	AB	11.
Tea and Sugar	2 tbsp.	....	25.	....	100.	.....	....	.....	....
Supper:									
Asparagus	Serving	1.3	3.9	.3	24.		8.	B	94.
Cauliflower	Serving	1.3	3.9	.3	24.		5.3	AB	92.
Butter	2 pats			17.	158.	.....	....	ABDG	2.
Tomatoes—raw	Small serving	.7	2.	.1	12.9		2.8	ABC	48.
Lettuce—raw	Small serving	.7	2.	.1	12.9		3.7	ABCDEG	48.
Fruit	Generous	2.	31.8	1.2	150.	.....	14.	ABC	200.
Honey	2 tbsp.	.2	48.7	....	200.			AB	11.
Tea and Sugar	2 tbsp.		25.	....	100.	.....	....	.....	
		17.5	361.3	45.6	1971.	2.	90.8		1176.

Butter perhaps less, but will increase protein above .25.

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HYPERGLYCEMIA FOLLOWING HEAD INJURIES

AN EXPERIMENTAL CLINICAL STUDY*

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EVER since Claude Bernard's [1] discovery in 1855, that a puncture of the tip of the calamus scriptorious will cause hyperglycemia and glycosuria, the possibility of a neurogenic diabetes has been discussed again and again. Leading authorities in diabetes, such as von Noorden, Joslin, Umber, have always held that diabetes is unthinkable without a pancreatic lesion. Following the mass experiment of the World War, in which the large number of head and peripheral nerve injuries have not resulted in any increase of diabetes among the injured, von Noorden [2] stated that neurogenic diabetes is a myth. Joslin [3] corroborated his view on the basis of extensive statistics. Nevertheless the medicolegal question of responsibility for diabetes in patients who have suffered head injuries is frequently raised. In previous editions of his book, von Noorden [2] has acknowledged traumatic diabetes before a court if:

1. Urine analysis was available and found negative before and positive within the first twelve months following the injury.

2. If an individual in good health lost weight and strength following the injury and showed clinical signs and symptoms of diabetes even if the urine has not been tested before and immediately after the injury.

He has even admitted the possibility of traumatic diabetes if a seemingly well man developed the disease within the first and second year following an injury. As it is not necessary for a diabetic to show glycosuria in all samples, the first few urine examinations following the injury may not have contained sugar.

These extremely liberal requirements were followed in certain courts in spite of the fact that gradually less and less belief in a true traumatic diabetes prevailed. On the other hand, a great number of case reports of traumatic glycosuria have been collected by Naunyn,[4] Higgins and Ogden,[5] and many others. Only the recent cases cited in von Noorden's and Joslin's monographs, and the studies of Konjetzny and Wieland [6] and Davidson and Allen [7] have reported blood sugar determinations following injuries. The former group found a transient glycosuria, lasting three to five days, in 42.4 per cent. following fractures of long bones, and an alimentary glycosuria following the oral administration of fifty grams of dextrose in 11 per cent. of their fracture cases. Three patients, who knew nothing of their diabetes, sustained fractures, and at the first urine examination sugar was found which

* Read before the Chicago Surgical Society, February 3, 1928.

persisted. All three came to autopsy later and typical liver and pancreatic cirrhoses were found.

Davidson and Allen [7] have made sugar tolerance studies of patients suffering from concussion of the brain and skull fractures, using twenty-five grams of dextrose intravenously for testing sugar tolerance. The average fasting blood sugars after concussions and skull fractures were found to be normal but the *sugar curves were high and delayed in returning to normal.* Subsequent observations showed that the abnormal curves did not persist. They believe that the more serious the injury, the more striking was the alimentary hyperglycemia.

Purpose and Scope of This Study.—We have studied the question of hyperglycemia following head injuries to answer, if possible, the following questions:

1. How often does hyperglycemia follow a head injury?

2. How long does the disturbance in carbohydrate metabolism last and may it gradually go into diabetes?

3. If this disturbance is of nervous origin, how can it be tested, and can the test be used in determining the presence of residual damage following injury to the brain?

Methods of Animal Experiments.—First Series. Ten healthy dogs, used to kennel life and fed on the usual diet, which maintains an ample glycogen storage of the liver † were hit on the vortex of the head with a wooden hammer. The dogs were stunned by the blow and remained unconscious from five to twenty minutes. They all passed urine, and most of them defecated. They showed muscular rigidity with twitchings. In our first experiment we laid stress on obtaining signs of basal skull fractures, such as bleeding from the nose, mouth or ears. X-rays were taken of the skulls of these dogs to demonstrate the fracture. Later we found that a loss of consciousness was all that was necessary to obtain changes in the blood sugar and that a fracture was not essential.

Dogs were fasted twenty-four hours before the injury. Samples of blood were taken immediately before and one-half, one, two and three hours after the injury from the saphenous vein. The samples were immediately precipitated and the blood sugar was determined by the Folin-Wu method. Hæmoglobin determinations were made in some cases to determine possible changes in the concentration of the blood.

Chart I shows the ten curves, in which with the exception of one dog all show a marked rise of blood sugar. It was not possible to afflict the same degree of injury on all dogs, and this factor, aside from the individual response, must also be taken into consideration.

Second Series. Ten healthy dogs were submitted to a bilateral division of the splanchnic nerves. The operation was performed under morphine-

† Glycogen determinations were made for other purposes in such dogs. From 5 to 6 per cent. glycogen was found by the Pfleger method.

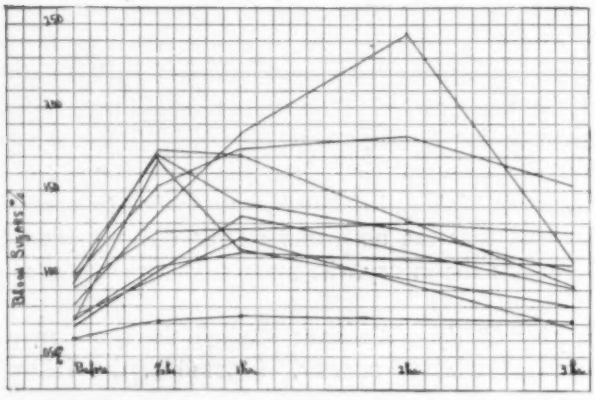

CHART I.—Blood sugar determinations on dogs, at short intervals, following head injury.

atropin-ether anæsthesia. A mid-line incision was made just below the xyphoid cartilage and the splanchnic nerves were exposed between the posterior crus of the diaphragm and the adrenals in the retroperitoneal space. Care was taken not only to cut the main trunk but also some smaller fibres, which correspond to the lesser splanchnic nerve in man. Not less than ten days after the operation, when the animal fully recovered, the head injury as described was performed and samples of blood were taken at the same intervals as in the first series.

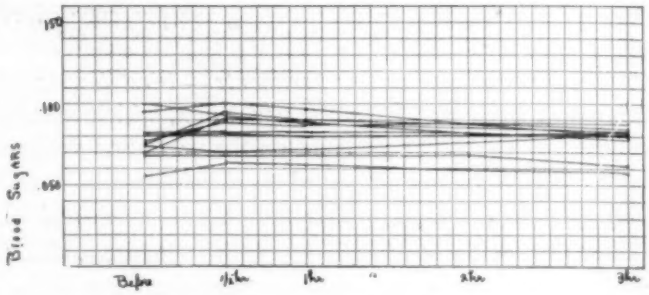

CHART II.—Blood sugar determinations following head injury. Splanchnics have been previously cut.

Chart II illustrates the blood sugar curves after the splanchnics have been cut. In not one instance has there been a rise above 100 milligrams per 100 cubic centimetres of blood, which is well below the upper limit of normal.

In Chart III the averages of the two foregoing curves have been drawn, which forcibly illustrate the effect of splanchnic block on the traumatic hyperglycemia.

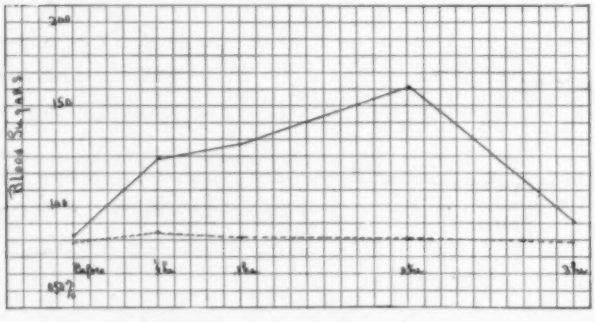

CHART III.—Average curves illustrating the effect of splanchnic block on hypergycemia following the head injury. Straight line (———): before section of the splanchnics. Dotted line (.....): after section of the splanchnics.

Third Series. Six dogs were given 2.5 grams of glucose per kilogram body weight in 20 per cent. solution intraperitoneally to determine their blood sugar tolerance. The dogs were then submitted to the head injury and their sugar tolerance again determined nine or ten days following the injury.

Chart IV compares the average of the sugar tolerance curves. While the peak is much higher after the injury, after one hour the figures are almost identical.

Methods of Clinical Research.—All head injury cases admitted to the service of one of us (Dr. H. E. Mock) at St. Luke's Hospital had the following tests:

1. Five cubic centimetres of blood were taken on admission, usually within an hour after the injury.

2. Other samples were taken, if possible, three, six, and twenty-four hours following the injury. During this period the patients were unconscious, and received only small amount of fluids and absolutely no carbohydrates.

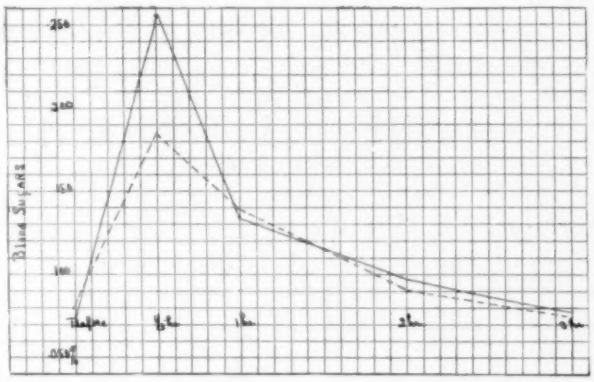

CHART IV.—Sugar tolerance curves before and within ten days following the head injury. 2.5 grams glucose per kilo weight in 20 per cent. solution was injected into the peritoneal cavity. Dotted line (.....): before; straight line (———): after the injury.

3. Within a week following the injury, an epinephrin hyperglycemia curve was determined. After twelve hours of fasting, a sample of blood was removed. One cubic centimetre of epinephrin 1:1000 was injected subcutaneously and further samples were taken at one-half, one, two, and three hours. The reason for substituting the epinephrin response for a sugar tolerance test will be discussed later.

As the patients arrived at the hospital at all hours of the day and night it was found helpful to use a preservative instead of the potassium oxalate. The blood samples were preserved in a mixture of sodium fluoride ten grams, thymol one gram, adding about five centigrams to five cubic centimetres of blood. The blood was kept in the ice box and determined together with the three, six and twenty-four hour samples within forty-eight hours. Repeated checks showed that the preservative was efficient and maintained the sugar level for several days. The method has been used extensively by Nadler and Starr [8] in determining blood sugars from out-of-town diabetics. It was to be expected, that higher blood sugar levels would drop more readily, but this was not the case in our experience ‡. The following example illustrates the efficiency of preservation:

Immediate precipitation 0.151 per cent.
Twenty-four hours in ice box 0.156 per cent.
Six days in ice box 0.156 per cent.

‡ Exton doubts whether this method is reliable. For our purposes this method proved very satisfactory.

TABLE I

Blood Sugar Determinations Within Twenty-Four Hours Following the Head Injury

Patient	Age	Sex	Clinical Diagnosis	X-ray	1 Hour* Per cent.	3 Hours* Per cent.	6 Hours* Per cent.	24 Hours* Per cent.
R. S.	29	F	Suspected skull fracture. Semi-conscious.	Negative.	.100		.125	.121
L. N.	22	M	Fracture of temporal bone.	Confirmed.		.120	.121	.91
H. F.	39	M	Basal skull fracture.	Linear fracture of frontal and sphenoid bones.	.149		.122	.75
T. D.	25	M	Suspected skull fracture. Concussion.	Negative.		.129	.131	.92
S. R.	22	F	Depressed frontal fracture. Fracture of nasal bones.	Comminuted fracture left.	.220	.183	.157	.139
C. H. F.	25	M	Fracture of anterior fossa.	Linear left temporal fracture		.165	.120	.115
H. P.	37	M	Suspected fracture. Concussion.	Negative.		.151	.143	.110
F. G.	31	F	Fracture of anterior fossa.	Linear fracture of orbit.			.129	.115
F. N.	48	F	Basal skull fracture.	Left frontal and fracture sphenoid.		.140	.128	.110
M. D.	50	F	Fracture of anterior fossa.	Fracture of left frontal and temporal bones.	.153	.153	.181	.181

* Hour designates time elapsed between injury and determination of blood sugar.

Results of Clinical Investigation.—Single samples taken from patients within the first twenty-four hours. Ten patients were examined. It is true that the first sample was not a fasting blood sugar, as patients had eaten before the injury. Subsequent samples however also showed elevations of the blood sugar in spite of the precautions described above. Red-cell counts and hæmoglobin determinations did not show such elevations as to account for the high sugar values by dehydration. Table I summarizes our findings. All patients had a higher sugar level than a few days later from which we can reasonably deduct that their blood sugar before the injury was also normal. It must be noted that all patients had lost consciousness, while not all of them had a proven fracture.

Epinephrin Curves Within a Week Following the Injury.— Ten epinephrin curves are available. It was to be expected that great individual differences would occur, on the basis of which patients could be divided into epinephrin susceptible and non-susceptible individuals. All curves, however, taken on control cases, showed a peak within an hour, the maximal rise not exceeding 100 per cent. of the original fasting value. Furthermore, the sugar level came back to normal at the end of three hours.

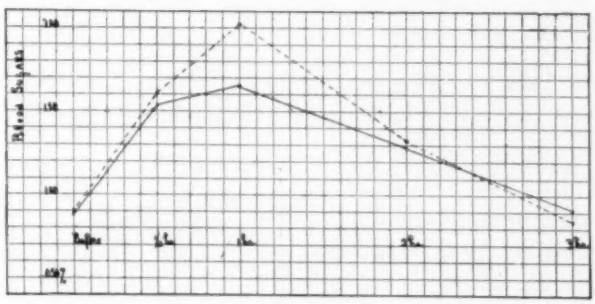

CHART V.—Epinephrin hyperglycemia curves in man. One cubic centimetre of 1:1000 epinephrin was injected subcutaneously. Straight line (———): average of five determinations on normals. Dotted line (.....): average of nine determinations within a week following the head injury.

Chart V illustrates an average of five determinations in normals compared with epinephrin curves taken within ten days following the injury.

Of the ten epinephrin curves taken on patients one week following the head injury eight showed a rise above 100 per cent. One case, however, showed in addition a delay in return to normal.

Mrs. Mary D., fifty years of age, received a linear fracture of the left frontal and temporal bones on November 23, 1927. Her blood sugar values within the first twenty-four hours are shown in Table I in the last column. It can be seen that at twenty-four hours the blood sugar was still 0.181 per cent. Six days later her epinephrin curve was the following (Chart VI): While the peak is just 100 per cent. of the fasting value, the descending limb of the curve is very gradual. At the end of three hours the sugar level is still 45 per cent. above the starting point. She was discharged with a ptosis of the left upper eyelid and while the ptosis still persists could not be examined since she has refused to allow further blood studies.

This patient had an unusually long hyperglycemia following the head injury. Furthermore, her delay in bringing the epinephrin hyperglycemia down to normal may indicate a pancreatic insufficiency.

Epinephrin Curves Several Months or Years After the Head Injury.—Eight patients were available for study. Of these, three patients gave a rise in blood sugar above 100 per cent. Chart VII shows their epinephrin curves with the salient data of their residual symptoms; all show a rise above 100 per cent. However, in two cases the sugar level rose only very slightly and did not return to normal in three hours. (Chart VII.)

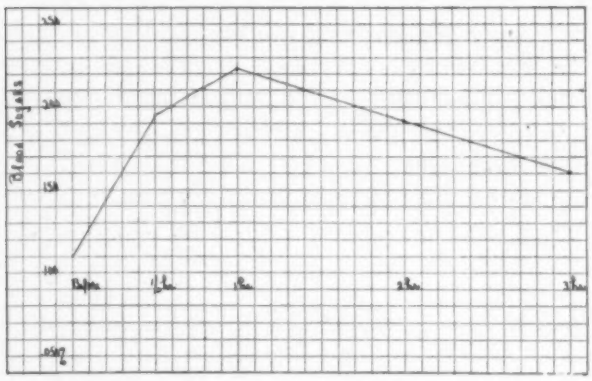

CHART VI.—Epinephrin curve six days following fracture of the anterior fossa. Mrs. M. D., aged fifty. Marked delay in returning to initial level.

Comment.—The interruption of an efferent impulse from the brain to the liver could be uniformly established by section of the splanchnic nerves. The pathway of stimulation following Claude Bernard's *piqûre* has already been established by Claude Bernard himself and later amplified by Eckard.[9] According to Freund and Marchand, Stewart and Rogoff,[11] the piqûre hyperglycemia is effected by an action of the sympathetic fibres in the liver so that the presence of adrenals is not absolutely necessary, although they play an important rôle in the normal animal.[12] The piqûre centre has been more closely analyzed by the studies of Brugsch, Dresel and Levy[13] who found that the origin of sympathetic impulses concerned in piqûre hyperglycemia was in the dorsal third of the vagal nucleus. If the anterior part of this nucleus were injured, a hypoglycemia resulted. Thus the dorsal portion of the nucleus of the vagus is a centre for blood sugar regulation. Aschner[14] injuring the hypothalamus could also produce glycosuria. This centre is probably identical with the sympathetic centre of Karplus and Kreidl[15] in the hypothalamus. Further centres for blood sugar regulation

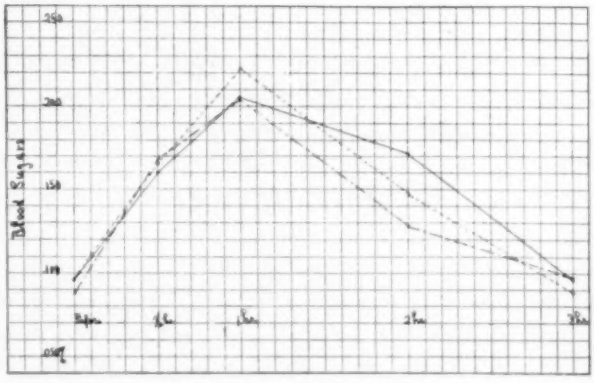

CHART VII.—Epinephrin curves of three patients several months following the head injury. All three had residual symptoms. Note the rise above 100 per cent. at the first hour and the normal return. Straight line (———): Lillian K., aged twenty-nine. Basal skull fracture sixteen months previously. Occasional headache, ptosis of right upper eyelid, limited upward rotation of right eye. Right pupil larger than left. Dotted line (....): Stella H., aged twenty. Basal skull fracture twenty-two months previously. Occipital and left temporal headache. Total deafness left ear. Otherwise negative. Interrupted line (—.—.—.): Dorothy R., aged twenty-five. Linear fracture at base three months previously. Occipital headache at times. No other residual symptoms.

are claimed to be present in a nucleus around the third ventricle (nucleus periventricularis) and the highest one in the corpus striatum.[16] Experiments of Morita [17] would indicate that the removal of both hemispheres has no influence on sugar regulation. While the exact dignity and relationship of these centres are far from being solved, it seems that the blood sugar regulating centres constitute a very important mechanism, comparable to heat regulation.

The head injury as inflicted in our animal experiments and as seen in clinical cases, may start a sympathetic discharge not only from the floor of the fourth ventricle but from the midbrain and interbrain. The impulse can be blocked by the section of the splanchnic nerves. An increased irritability can be demonstrated in the animal experiments up to the tenth day. It manifests itself in a sudden rise of the sugar tolerance curve, which reaches a higher level than before the injury. It is important to note, however, in Chart IV, that the blood sugar drops in one hour to the same level as before the injury. The insulin response to the high sugar level is presumably intact, since the descending curve is not delayed.

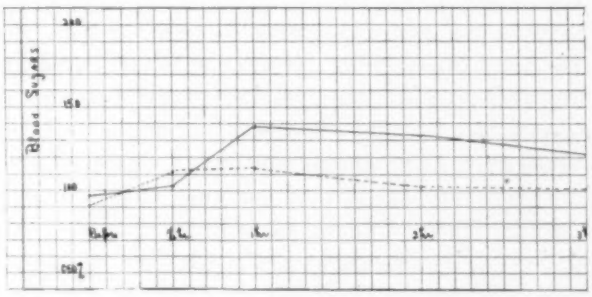

CHART VIII.—Epinephrin curves of two patients several months following head injuries. They had no residual symptoms. Note the small rise but the delayed return to normal. Straight line (———): Sam. Br., aged forty-three. Basal skull fracture twenty-five months previously. Unconscious. Made complete recovery. Dotted line (.....): Charles F., aged thirty-three. Fracture of left temporal bone extending down to mastoid process. Semiconscious. Injury sixteen months previously. Made complete recovery.

Because of our findings in the animal experiments and also because of the difficulty or impossibility of running oral sugar tolerance curves on unconscious or semiconscious patients we selected the epinephrin test for testing an increased irritability of the sympathetic sugar regulation. It is true that intravenous sugar tolerance determinations could have been made. Such were used by Davidson and Allen in their studies of carbohydrates metabolism following head injuries. However, such a sudden rise in blood sugar is not comparable with a slow absorption through the portal circulation and the curves cannot be interpreted as true tolerance curves.

Our blood sugar determinations, taken at short intervals following the injury, *showed a rise in blood sugar in every instance.* There is then quite a constant hyperglycemia following head injuries. This fact can be easily overlooked if samples are not taken early enough as in Davidson's and Allen's series. We were struck by the coincidence of loss of consciousness with hyperglycemia. This factor and not the fracture or the increase in intracranial pressure seemed to be of most importance. The same observation has been made recently by Bstek and Driak [18] in Eiselberg's Clinic. They think it quite probable that the midbrain and interbrain are involved in the loss of consciousness.

The interpretation of the epinephrin curves is difficult. Individual differences are great and naturally no means of comparison are available from the same patient, previous to the injury. However, a number of normal curves are known from work of Broesamlen.[19] Billigheimer,[20] Petenyi and Lax.[21] The peak of the blood sugar curve is reached within an hour; it never exceeds 100 per cent. of the initial value and is usually 50 to 60 per cent. of the fasting blood sugar. The curve is back to normal in three hours.

The suggestion to test a residual cranial injury by the help of a persistent sympathetic irritability presupposes the possibility that a traumatic injury to the brain, such as minute hæmorrhage, blood clot or traumatic cyst, may be a constant source of irritation to the sympathetic centres and pathways. That a lesion of the basal ganglia may maintain a state of constant movements, as in paralysis agitans, is known and is suggested as an analogy. That this sugar mobilizing impulse is compensated in the normal individual, is reasonably to be expected, knowing the resources of the body to maintain normal blood sugar. However, when the epinephrin hyperglycemia fails to return to normal within three hours, an insufficiency of insulin output should be considered. In three of our cases such a delay was noted, one immediately and two several months following the injury. All three were above the age of forty. The importance of such findings even in a small series like ours must be emphasized. It is quite probable that a number of individuals about the age of forty have a diminished insulin reserve without, of course, being manifestly diabetic. The question arises, whether a prolonged sympathetic discharge, which occurs after head injuries, and calls for additional insulin output, may not result in a relative pancreatic insufficiency. In other words, can a head injury overtax an already impaired pancreas to an extent that a pancreatic insufficiency develops?

We do not believe that our few data solve this problem but we do offer a method of testing the sequelæ of head injuries, a method that presumably tells us how readily the pancreas can eliminate the excess of blood sugar, which resulted from the stimulation of the sympathetic fibres by the injection of epinephrin.

From a clinical standpoint every head injury sufficiently severe as to cause unconsciousness causes a temporary disturbance in sugar metabolism. If the patient has diabetes or an insufficient insulin response which predisposes him to diabetes this temporary upset in sugar metabolism may readily make worse or precipitate an actual diabetes. We believe to this extent the head injury may be looked upon as the exciting cause of the diabetes—the true cause being due to the usual pancreatic lesion. The bridge between a temporary traumatic hyperglycemia and true diabetes is a strong sympathetic discharge requiring adequate insulin response. If the latter is not available a breakdown of sugar regulation may ensue.

From our observations of a very large series of head injury cases, observed months to years following the injury, watched especially from the

standpoint of a true diabetes following the injury, we agree with other observers that the condition is extremely rare.

The practical points which have been developed as a result of this study and which may have a clinical application are:

1. The epinephrin injections, followed by glycemia determinations, can be used in cases of old head injuries, claiming or showing certain residual signs or symptoms, to determine if these are really due to continued or persistent cerebral irritation.

Example.—In four cases of old skull fractures, claiming dizziness, headaches, ringing in the ears and anxiety neuroses referred for examinations within the last three months this test was made; in three it showed a delay in return to normal in the hyperglycemia curve, but in the third there was no delay in return to normal. In this case we felt his condition was a pure hysteria—a compensation hysteria rather than a true persistent cerebral contusion. These four cases, combined with the eight shown in Chart VII, make twelve cases of old skull fractures studied. In six, all showing residual signs, the epinephrin curve test was positive. In one the negative epinephrin curve test helped in the differential diagnosis between a hysteria and true persistent cerebral irritation.

2. We believe this test should be made upon every head injury case before he is discharged from treatment. If the test is normal at the end of treatment period, we do not believe that any subsequent diabetes which might develop could justly be attributed to the head injury. On the other hand, if a patient at time of discharge shows a disturbed carbohydrate metabolism by this test and then later should develop true diabetes the injury could rightly be held as an aggravation or as the exciting cause—the true cause, of course, being a pancreatic pathology.

This test with the glycemia determinations therefore may prove to be a positive method of securing a real answer to this very old medicolegal problem.

3. In a recent case of skull fracture the patient was progressing exceedingly well when suddenly she went into coma which rapidly became profound. There was a strong acetone odor to her breath and the coma resembled more a diabetic coma than one due to hæmorrhage with cerebral compression. There were no focal signs indicating cerebral involvement. A blood sugar determination was made which showed a very marked hyperglycemia. Inquiry then revealed the fact that she had been treated for diabetes some fourteen years previously. If a blood sugar determination had been made immediately this condition would have been discovered in time most probably to prevent coma and death.

Therefore the most practical deduction from this study may be stated as follows:

Every head injury severe enough to cause cerebral injury has within the first twenty-four hours an increase in blood sugar; if there is a diabetic tendency this upset in carbohydrate metabolism may become a serious menace; therefore, every such case should have a blood sugar determination

made within the first twenty-four hours. From a medicolegal standpoint every patient who has suffered a head injury and particularly those with loss of consciousness should have a routine fasting blood sugar three or four times within the first year, together with an epinephrin curve a few weeks after the injury. The epinephrin hyperglycemia simulates the traumatic one in many respects and appears to be a good check for testing for residual symptoms. If the fasting sugar and the epinephrin curve, particularly its downward course, seem normal during the first year liability for a later developing diabetes cannot be acknowledged. If the sugar values are persistently high and the epinephrin curves show a slow drop to normal, the patient must be regarded as a potential diabetic and if actual diabetes later developes the injury must be held as an exciting cause.

CONCLUSIONS

1. Head injuries of sufficient severity to cause loss of consciousness result constantly in hyperglycemia, which subsides within the first day or a few days. This has been found in animal experiments and in a small number of clinical cases.

2. Section of the splanchnic nerves in the dog abolished this hyperglycemia. The sympathetic discharge originating in the higher centres of sugar regulation is unable to reach the liver and mobilize glycogen.

3. This state of sympathicotonia manifesting itself in increased epinephrin susceptibility was tested in patients shortly after and many months following the head injury. While the immediate response was stronger than in controls, the late curves were mostly negative with the exception of those who had marked residual damage.

4. A few patients were found whose epinephrin curve was not abnormally high but showed a delay in returning to normal. These patients were all above forty years and may have a mild pancreatic damage. This is not uncommon at this age and deserves careful consideration.

5. This small series cannot entitle us to make any further statements and only suggests a method of studying head injuries and their sequelæ. Theoretically, however, the possibility of upsetting an already weakened pancreatic activity by a sudden sympathetic discharge, followed by a marked rise in blood sugar, must be considered.

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THE PART WHICH IODINE HAS PLAYED IN THE TREATMENT OF PATIENTS WITH EXOPHTHALMIC GOITRE*

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A short review of the development of surgery for exophthalmic goitre is interesting. The mortality following the early operations performed for this disease was extremely high. This, no doubt, was due to the type of operation used and lack of knowledge of the clinical course of the disease. When it was recognized that patients with acute hyperthyroidism could be operated on only with great danger, and that many of these, following medical management, later improved sufficiently to allow operation to be more safely performed, the mortality following operation became lower. Recognition of this fact, no doubt, caused more intensive study of the clinical course of exophthalmic goitre and it was learned that the disease in most cases ran a rather typical course, during which there were periods of progression and regression of the acuteness of the symptoms.

Ligation of one or both of the superior poles of the thyroid gland was then introduced and this procedure was thought to cause more rapid regression of the symptoms of the disease. It soon was learned that even ligations could be performed safely only on patients in whom the disease had not progressed too close to a crisis and on those who were in a regressing period of the disease. At first, ligations were done in severe cases as measures preliminary to thyroidectomy, and in mild cases as curative measures. Later, ligations were often used to test the ability of a given patient to stand a more radical operation, such as thyroidectomy. Ligations played an important part in the development of surgery for exophthalmic goitre and through their use the mortality was considerably lowered. There is some question, however, as to the real manner in which ligations caused regression of the acute symptoms of the disease, and it is possible that the improvement which followed their use may have come from postponement of the thyroidectomy for several months, as was usual after ligations were performed.

The mortality after ligations were used was still sufficiently high to cause differences of opinion among physicians as to whether or not surgery was the best means of treating patients with exophthalmic goitre. In well-organized clinics, where large numbers of patients with exophthalmic goitre were being operated on, the mortality was relatively low. However, following thyroidectomy done by operators, who were inexperienced in dealing with this disease and who rarely performed thyroidectomy, the mortality was high. Because of the mortality and poor end results following operation in certain cases, many patients dreaded the thought of operation and refused surgical procedures.

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Before the period when satisfactory metabolic tests were possible surgeons often failed to remove a sufficiently large amount of thyroid gland to eradicate completely the hyperthyroidism. The results following operation, therefore, were far less satisfactory than at present. After satisfactory methods for computing the basal metabolic rate were developed the end results, accordingly, were improved by forcing surgeons to remove a larger amount of thyroid tissue. On account of the mortality and the differences of opinion as to the best means of treating the diseases, röntgen-ray treatments which had been used to a certain extent for years again were revived and the treatments were given in much larger doses. These treatments were extensively used for a while, but have been largely discarded.

Iodine has long been used in various ways in treating exophthalmic goitre, but it usually was given with an idea of curing the disease instead of, as at present, preparing patients for operation. Some years ago, Marine stated that iodine tended to cause a regression of goitre of the hyperplastic type to goitre of the colloid type. The practical use of iodine as a means of preparing patients with exophthalmic goitre was not standardized to such a degree that it was of any particular surgical value and its use in the treatment of exophthalmic goitre had been largely dropped when it was revived by H. S. Plummer, in March, 1922. Plummer noted marked improvement following its administration in doses sufficiently large to supply the thyroid gland with enough iodine to permit it to produce normal thyroxine, and he quickly recognized its value as a means of preparing patients for operation and of controlling serious post-operative reactions. Plummer based the improvement which followed the use of iodine on the hypothesis that the thyroid gland in exophthalmic goitre was unable to deliver a normal product when the iodine supply was relatively low. In the early cases treated with iodine in The Mayo Clinic, it could scarcely be believed that hyperthyroidism in patients who presented themselves for operation during the acute stages of the disease could be controlled following a quickly performed thyroidectomy; therefore, the use of ligations was continued. Soon, however, it was found that primary thyroidectomy could be safely performed on many patients who had been prepared with iodine, and, from year to year since, the number of ligations performed has rapidly decreased. At the present time the operation of ligation is recognized by many as being practically an unnecessary measure in the treatment of exophthalmic goitre.

Since the standardization of metabolic tests and of the preparation with iodine of patients for operations, rapid advances have been made in the management of patients with exophthalmic goitre. When considered alone, the basal metabolic rate has been of no particular value as a means of determining when operation should be performed; it is regarded merely as an index to the degree of hyperthyroidism present when it is taken. The reaction of a patient with exophthalmic goitre after treatment with iodine really has proved of greater value in the treatment of the patient than a knowledge of changes in the basal rate. The knowledge of basal rate has been of value in aiding in the diagnosis of exophthalmic goitre in certain early and atypical cases, and

has been a helpful means of noting improvement. It, also, has been a very valuable method of determining, after operation, whether hyperthyroidism still exists and whether hypothyroidism is present.

Through the use of iodine it has been possible rapidly to prepare patients for thyroidectomy and to control serious post-operative reactions. Mortality has been greatly reduced, and since it is possible to perform thyroidectomy earlier, the long duration of hyperthyroidism, which was so harmful to patients treated by the older methods, has been greatly diminished. In this way the morbidity and the expense to patients have been greatly reduced. Better end results are obtained because thyroidectomy is performed in many cases before exophthalmos or serious organic changes have occurred. The poorest end results following operation at present occur in patients operated on after a long-continued period of hyperthyroidism and who at the time of operation show evidences of marked organic disease. Before patients were prepared for operation by the use of iodine, it was possible in only about 30 per cent. of the patients to perform safely a primary thyroidectomy, and it was necessary, in about 70 per cent., to use preliminary operations, such as hot water injections or ligations. Often, long-continued pre-operative medical treatment was necessary before these preliminary measures could be safely done.

In 1927, 1520 patients were operated on in The Mayo Clinic for exophthalmic goitre. Ligations were done in only nine of these cases. Ligations have not been performed so far (December 11) during the year 1928. Patients with large goitres of long standing, who respond poorly to iodine treatment and who, as a rule, have lost much weight and strength, are still seen. On these, one still may feel inclined to perform ligations in order that the patients may be given time to gain weight and strength. Except in this group of patients, however, ligations are seldom indicated. At the present time, the mortality following operations on patients who come for operation during the first six months or even during the first year after the onset of the disease, and who have been properly prepared with iodine, probably is no greater than that which would follow thyroidectomy on a normal individual.

The use of iodine in preparing patients with exophthalmic goitre for operation may be looked on as having brought about the following changes:

1. *Reduction of Mortality.*—Marked reduction in mortality has followed the use of iodine in preparing patients for operation. In 1520 patients operated on in The Mayo Clinic in 1927 for exophthalmic goitre, there were eleven deaths, a mortality of 0.72 per cent. In this group were included early, late and recurrent cases. In cases in which operation was performed within the first six months or even during the first year following the onset of the disease, the mortality was practically nil. A death in such cases usually is an accidental one, due to secondary hæmorrhage, injury to a nerve or to the development of an acute pulmonary infection following operation. Only a few years ago it was not uncommon for death to occur in certain cases during the very acute stages of the disease before operation. At present death

in such cases rarely occurs as it is possible, through the use of iodine, to control rapidly serious hyperthyroidism in practically all cases.

2. *Reduction of Morbidity.*—Patients are subjected to thyroidectomy much earlier than formerly and during a period of the disease before marked organic changes have occurred. The end results, therefore, following the early performance of thyroidectomy have been far better.

3. *Saving of Time to Patients.*—Since iodine has been used to prepare patients for operation, much time has been saved for them. It usually is possible in early cases of goitre to prepare patients for thyroidectomy within eight days to two weeks after the use of iodine has been started. Furthermore, it is possible now for most patients who come early for operation to return much sooner to their former work. The elimination of preliminary operations in practically all cases also has greatly diminished the delay formerly necessary before thyroidectomy could be performed safely.

4. *Reduction of Expense to Patients.*—Because of the short time necessary to prepare patients for operation and the ability to perform primary thyroidectomy on patients who come early for operation, the hospital expense to patients has been greatly reduced. The majority of patients may be prepared while living in their homes, in boarding-houses or in hotels and may be sent to the hospital for operation after the preparation has been completed. In this way many patients remain in the hospital only five or six days. The ability to have a thyroidectomy quickly performed and to return early to work has meant a tremendous saving in expense to patients with this disease.

5. *Diminution of Recurrences.*—Early operation, the use of iodine following operation and the removal of a larger amount of glandular tissue have diminished materially the percentage of recurrences. When there is recurrence it often may be controlled by further use of iodine. Should this fail, however, to control the hyperthyroidism after a reasonable time, the assumption usually is either that too much thyroid tissue was left at operation or that the thyroid tissue left has undergone hypertrophy. In such cases, a portion of the thyroid tissue present is removed in order to reduce the basal metabolic rate to normal and thus to prevent the slow organic changes which will develop following long-continued, low-grade hyperthyroidism.

6. *Diminution of Difficulties of Operation.*—Thyroidectomy, as a rule, may be performed more easily on patients operated on early in the course of the disease than on those operated on following long-continued hyperthyroidism and who present themselves with large, hard, vascular, friable glands. The operations in the early cases are easier because of a greater amount of colloid material in the gland. The possibility of post-operative complications, such as secondary hæmorrhage and injury to a nerve, also is lessened in cases in which operation is performed early.

Comment

On account of the great number of patients directly affected by treatment with iodine in preparing them for operation for exophthalmic goitre, I believe it may be looked on as being the most important advance that has been made in any branch of surgery since its introduction in 1922.

TREATMENT OF ABDOMINAL INJURIES IN CHILDREN *

WITH THE REPORT OF FIFTY-NINE CASES

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With the increased use of the automobile and the consequent greater number of street accidents, injuries to children have become more numerous. This is particularly evident in the general hospitals in large centres of population. Among the many types of injuries observed, there are none of more interest to the surgeon than those with the signs of damage to intra-abdominal organs. In these the patients are often admitted to the ward in a state of profound shock, with shallow respiration, rapid thread-like pulse, and rigid retracted abdominal muscles. A condition of affairs in which it is evident that an immediate decision must be made; as operative interference is required to save life in some types of abdominal injury and is unnecessary in others; an error at this time may result in the loss of the patient's life.

Some years ago, a child, nine years of age, was seen who, shortly before admission, was run over by an automobile; one of the wheels was said to have passed over the upper abdomen. The boy was in a state of profound shock, pale, with frequent shallow respiratory movements and a rapid thread-like pulse. The abdomen was retracted, the muscles stiff and board-like and there was marked tenderness over its upper half. An exploratory laparotomy was performed; the peritoneal cavity was found to contain a slight amount of blood-stained serum, but no intra-abdominal injury was discovered. The following day the patient coughed up a small blood clot and later a right pneumothorax was discovered. The boy recovered, but how much better for him if he had not been operated upon.

A boy, ten years of age, was admitted to the Surgical Ward of the Lincoln Hospital, having been run over by an automobile. The patient was in a state of severe shock; his abdominal wall was retracted, rigid and tender over the entire surface. The respiratory movements were altogether thoracic in character. There were no signs of fluid or gas within the abdomen and the urine contained no blood. There followed a period of reaction in which there was an improvement in the color of his skin and character of his pulse; however, this did not last long, for at the end of twenty-four hours signs of peritoneal irritation appeared. He became restless, vomited, and his abdomen was distended and tender. These symptoms were progressive in intensity until the boy died at the end of three days. Fortunately, an autopsy was obtained. The examination disclosed a large hæmatoma infiltrating the retroperitoneal space. The source of the hæmorrhage could not be found as there was no injury to any of the intra-abdominal organs. Before the findings of the post-mortem examination were known, it was thought that a grave error in judgment had been made. However, later it was evident that operative intervention would have been useless for there was nothing that could have been gained by it.

Recently, a series of fifty-nine case histories of patients who showed signs of intra-abdominal injury were collected from the Children's Surgical Service, Bellevue Hospital. This series contains thirty-two cases in which the diagnosis was confirmed by operation or autopsy, fourteen in which the

* Read before the Surgical Corps of the Lehigh Valley Railroad.

clinical symptoms were thought to be of sufficient evidence to place the injury, and thirteen in which a precise diagnosis could not be reached. It is to be regretted that the records of more patients who recovered, in which the diagnosis was uncertain, were lost through being filed under the large group of "Diagnosis Unknown"; consequently, the mortality rate of the series is not obtainable. Thus there were forty-six cases in which the diagnosis was reasonably certain, and thirteen in which the injury could not be localized.

TABLE I

Cases Reported

			No. of cases
Injuries to chest			8
Injuries to chest and abdomen	Lung and liver	3	
	Lung, liver and spleen	1	4
Injuries to intraperitoneal organs	Spleen	2	
	Liver	7	
	Liver and spleen	3	
	Liver and kidney	1	13
Injuries to intestinal tract			3
Injuries to large vessels			2
Retroperitoneal hæmorrhage	Pelvis fractured	3	10
Intra-abdominal injuries, organs unknown			13
Injuries to kidney			6
	Total		59

In those patients with injuries to abdominal organs that died, death occurred on the average of within two and a half hours following the accident, while those with injury to the lungs alone lived for at least five hours. The accompanying tables show the types of injuries in detail.

The injuries were severe in the thirty-one patients that died; four were operated upon; in nineteen the diagnosis was established by post-mortem examination, in two the injury, fractured pelvis, was discovered by the physical examination, and in three cases the exact diagnosis was not known, as the patients died within an hour following the accident. In the case of the six patients with ruptured lungs, the eight with injury to more than one organ, the two with laceration of large vessels, and the two with pelvis fractures, there were no evident indications for operation; this leaves those with injuries to the spleen and liver for discussion.

The patient with rupture of the spleen would have been operated upon if he had been seen early enough, but since he lived but three hours, there is doubt whether he would have recovered.

In the six cases of rupture of the liver, the question may be asked, "Should these patients have been operated upon?" Four of them died within two hours following their injury and two within three hours. It is, therefore, hardly conceivable that any of their lives could have been saved by operation and it is probable that the added shock would have hastened death.

There were twenty-eight patients that recovered. Of these children, six were operated upon; one for ruptured spleen, one for laceration of the small

intestine and four who had retroperitoneal hæmorrhage of unknown origin. The ten patients with unknown internal injuries were possibly cases of ruptured liver or retroperitoneal hæmorrhage.

TABLE II

Known Injuries to Organs in Chest with Abdominal Signs

Number of cases	Diagnosis	Evidence	Results
1	Ruptured lung	Autopsy	Died 24 hours
2	Ruptured lung	1 Operation, 1 Autopsy	Died 7 hours
1	Ruptured lung	Autopsy	Died 6 hours
2	Ruptured lung	Autopsy	Died 2 hours
	Chest and Abdominal Organs		
1	Ruptured lung and liver	Autopsy	Died 45 minutes
1	Ruptured lung, liver and spleen	Autopsy	Died 45 minutes
1	Ruptured lung and liver	Autopsy	Died 6 hours
1	Ruptured lung and liver	Autopsy	Died 2 hours
10			

Average life of deaths from ruptured lungs..... 8 hours
Average life of deaths from ruptured lungs complicated by abdominal injuries ..... 2½ hours

To summarize, in the whole series of fifty-nine cases there were ten operations; in four of them the indications were definite, one for ruptured spleen and three for laceration of the intestinal tract; in two of these the patients' lives were saved. In the remaining six cases the operations were merely exploratory in character. One of these patients had a ruptured lung and died, another had an injured kidney with a large retroperitoneal hæmorrhage, he also died. The four remaining children had retroperitoneal hæmorrhage of unknown origin; they all recovered in spite of the added shock from the operation. Of the ten operative cases in only four was the procedure warranted.

It is apparent, from the study of these cases, that it is not essential to submit all children with signs of abdominal injury to operation. In a small proportion of the cases (less than 7 per cent.) operative intervention is necessary to save life; in a larger group it is not required and will in many cases precipitate death by the added shock or hæmorrhage. It is evident that to carry out the proper treatment in an individual case the surgeon must know the condition he is dealing with. To determine this is difficult as in many injuries of the abdominal and thoracic organs the only symptoms are those of peritoneal irritation. For this reason, I believe, it has become a habit for some surgeons to explore every patient with signs of intra-abdominal injury, in the hope that he may find one of the conditions which can be benefited by operation. This would appear to be rather a small chance.

Injuries to the lungs frequently produce abdominal signs and children with this condition have been operated upon under the impression that the lesion was intra-abdominal. The local signs in the chest are often masked by the

more apparent abdominal symptoms. A ruptured lung in a child is the result of a severe trauma, in which the thorax has been suddenly compressed, as in the case where a wheel has passed over the chest. Many times a tear in the lung is present without a fracture of the ribs; this accounts for the infrequency of subcutaneous emphysema in these patients. The explanation of the injury to the lung without accompanying fracture of the ribs, is the relative elasticity of the thoracic cage of the child.

In addition to the general and abdominal symptoms, the local signs in the chest are those of a pneumothorax. The diagnosis can be confirmed by the use of the fluoroscope or a röntgenogram. The pneumothorax often remains for some period of time; in one patient it persisted for six weeks. This is due to the fact that a collapsed lung with a rent in it may act as a flap valve allowing air to enter the pleural cavity, but preventing its exit. This forced collapse of the lung by the increased intrapleural pressure often prevents a hemothorax. It is evident that there are no indications for operation in cases of ruptured lungs.

The liver, spleen or kidneys may be injured by comparatively slight trauma; a small blow to the body. Where more than one organ is injured there is usually greater violence. These organs because of their structure burst asunder when compressed, producing large ragged wounds.

The liver, because of its size and the poor protection afforded it by the ribs, is often injured. The wound in its substance may be a single fissure or an extensive stellate tear. The surfaces bleed freely and these injuries are consequently accompanied by severe shock. The abdominal signs may at first be localized to the upper right quadrant of the abdomen, but soon become general and death may rapidly follow; therefore, the diagnosis of ruptured liver is difficult. There is a difference of opinion among surgeons, as to the advisability of operating in cases of ruptured liver. However, I believe that more lives can be saved by the non-operative treatment. It is my experience that there are two types of cases: those in which it is found at operation that the hæmorrhage has stopped, and those where the tear is so extensive that it is impossible to produce hemastasis by either suture or packing. The manipulation at operation often renews the bleeding in the former type of case.

The spleen, because of its small size and position under the ribs, is seldom injured alone, but injuries to it occur more often accompanying those of the liver or kidney. Where the child is seen early the abdominal signs are found to be well localized to the left upper quadrant; occasionally, there may be a complaint of pain in the left shoulder. Operation is indicated in the case of a ruptured spleen, as complete hemastasis can be obtained by the ligation of its pedicle.

Tears of the intestinal tract seldom occur; when they do the shock is severe; the abdominal signs are at first of local peritoneal irritation followed by diffuse peritonitis. The presence of gas within the peritoneal cavity may be discovered by the absence of the liver dulness, but this is not always present, or it may be found by the X-ray. Operative treatment is imperative.

TABLE III

Known Injuries to Organs in Abdomen

Number of cases	Diagnosis	Evidence	Results
1	Ruptured spleen	Autopsy	Died 3 hours
1	Ruptured spleen	Operation	Recovered
2	Ruptured liver	Autopsy	Died 3 hours
3	Ruptured liver	Autopsy	Died 2 hours
1	Ruptured liver Fractured ribs	Autopsy	Died 2 hours
2	Ruptured liver Spleen Fractured ribs	Autopsy	Died 2 hours
1	Ruptured liver Spleen	Autopsy	Died 3 hours
1	Ruptured liver Kidney	Autopsy	Died 2 hours
12			
	Average life of the eleven deaths.....		2½ hours
1	Ruptured kidney (compound fracture of humerus)	Operation	Died 12 hours
13			

The indiscriminate operative treatment of patients showing signs of injury to the kidney has resulted in the needless removal of many renal organs. Only those cases with definite indications should be operated upon. Continuous bleeding or extravasation of urine are the most common conditions calling for exploration. Hæmorrhage, unless it be from a torn hilum, will usually cease spontaneously; however, if the pedicle is torn there is little chance of saving the individual's life.

TABLE IV

Known Injuries with Marked Abdominal Signs

Number of cases	Diagnosis	Evidence	Results
1	Ruptured ileum	Operation	Recovered
1	Ruptured ileum	Operation	Died 30 hours
1	Ruptured stomach	Operation	Died 6 hours
3			
1	Lacerations of mesentery	Autopsy	Died 2 hours
1	Laceration of vena cava	Autopsy	Died 2 hours
2			
2	Retroperitoneal hæmorrhage	Operation	Recovered
1	Retroperitoneal hæmorrhage (later abscess)	Operation	Recovered
1	Retroperitoneal hæmorrhage	Operation	Recovered
4			

In a series of nine cases of injury to the kidney, in children treated at the Lincoln Hospital, there was but one death. This was one of the three patients operated upon. The hilum of the kidney was badly torn and there was multiple fractures of the ribs. In the second operative case it was found that the kidney was not badly damaged. The third patient that came to operation had a definite indication for exploration. The boy was struck by an automobile; he was admitted to the hospital in a state of severe shock. There were signs of abdominal injury; a specimen of urine contained a few red blood cells, thereafter, the urine was blood free. In twelve hours the boy had recovered from shock; there was a rise in temperature at the end of twenty-four hours; at this time there were signs of dulness in the right flank. In forty-eight hours this dulness extended forward to the umbilicus; the patient was toxic. An extravasation of urine in the perirenal space was found at operation. The kidney was completely divided, the vessels of the hilum being attached to the larger upper fragment and the ureter to the lower. This explained the fact that blood was only found in the first specimen.

TABLE V

Injuries to Chest and Abdomen

Clinical Diagnosis

Number of cases	Diagnosis	Results
1	Lacerated lung	Recovered
1	Hæmorrhage into mediastinum	Recovered
1	Fracture of pelvis—retroperitoneal hæmatoma	Died 24 hours
1	Fracture of pelvis—retroperitoneal hæmatoma	Recovered
3	Retroperitoneal hæmorrhage	Recovered
3	Internal injuries—organs unknown	Died 1 hour
10	Internal injuries—organs unknown	Recovered
1	Internal injury—(liver)	Recovered
5	Ruptured kidney	Recovered
27		

A comparatively large number of injuries, in children, causing abdominal symptoms are conditions producing a hæmatoma in the retroperitoneal space. Hæmorrhage into this space may be due to injury of the kidney or to a fracture of the pelvis, but there are other cases in which there is a diffuse hæmatoma, where no large vessels have been divided, the hæmorrhage apparently coming from small ones. The symptoms and course of this condition are definite; the children are admitted in a state of extreme shock with rapid, shallow respirations and retracted abdominal walls. The abdominal muscles are rigid and the tenderness is diffuse from the start. Reaction usually occurs in six to twelve hours, though the abdomen may remain rigid for two to three days, this is followed by a distention of the intestines which occasionally lasts as long as a week. A slight rise in body temperature accompanies these symptoms.

SUMMARY

1. Symptoms of abdominal injury are found in children with damage to thoracic as well as to abdominal organs.

2. Injuries to the liver or those to more than one organ are accountable for the majority of deaths, which may follow the injury within a few hours.

3. Injuries to the spleen and intestines are relatively rare in children.

4. Retroperitoneal hæmorrhage is comparatively common following trauma to the abdomen of children.

5. Injuries to the kidney may follow slight trauma. Operative treatment is only advisable where there is a definite indication.

6. With the exception of a rupture of the spleen or the intestine, immediate operative interference is unnecessary.

7. It is believed that the lives of more children with injuries to the liver can be saved by palliative rather than by operative treatment.

8. For the proper treatment of abdominal and thoracic injuries an early diagnosis may be arrived at. Diagnosis by operative exploration is not justifiable as the lives of many children will be further jeopardized. Intelligent conservatism in the treatment of intra-abdominal injuries of childhood will save the greatest number of lives.

A TREATMENT OF PERSISTENT BRONCHIAL FISTULA

AN EXPERIMENTAL AND CLINICAL STUDY

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Celsus [8] is quoted as saying, "Fistulas of the chest are very difficult of treatment, so that sometimes physician, sometimes patient, giving up hope, leaves the case to Nature herself." Some of the instruments used by Hippocrates and Paulus Aeginata are described in the writings of Fabricius ab Aquapendente.[12] He stated that most persons who had received a penetrating wound of the chest had to wear a silver tube for life, and that he knew of patients who had carried tubes for twenty to thirty years. In discussing the treatment, he says the hard skin of the fistula should be removed either by softening or by instruments. Furthermore, "all corruption must be removed and the fistulous tract straightened by cutting the curves with a knife."

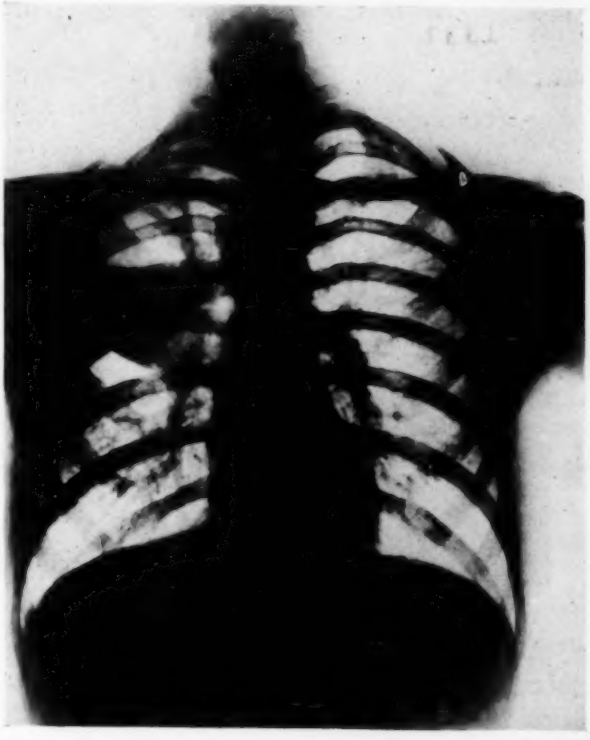

Fig. 1.—Case I. Abscess in right upper lobe showing the fluid level in the erect position.

From these early times, the subject of bronchial fistula has received occasional attention; not, however, until recent years has the subject been given scientific consideration and operative treatment been systematically attempted.

A bronchial fistula is a communicating tract between a bronchus and the pleural surface of the lung or cutaneous surface of the thoracic wall. There are, therefore, two types, broncho-pleural and broncho-cutaneous. On the basis of etiology, Eggers [11] makes the following classification: (*a*) those due to intrapulmonary suppuration; (*b*) those due to external violence which has produced a perforating wound of the chest wall.

It is probable that bronchial fistulas are most commonly encountered in empyema thoracis as a cause or complication of this condition. The major-

ity are small and heal spontaneously. However, in certain cases, a fistula may persist, and be the chief factor of the chronicity of an empyema cavity. A fistula may result from a lung abscess, either spontaneously if the abscess ruptures into the pleural cavity, or following the operative treatment of the abscess. In the same way, suppurative bronchiectasis may be the cause. A fistula not infrequently occurs in pulmonary tuberculosis as a result of tuberculosis cavitation. Other pathological conditions that may be directly or indirectly the cause of bronchial fistulas are: lung abscess caused by the aspiration of a foreign body, actinomycosis, gangrene of the lung, or pulmonary suppuration due to an extension from a neighboring organ.

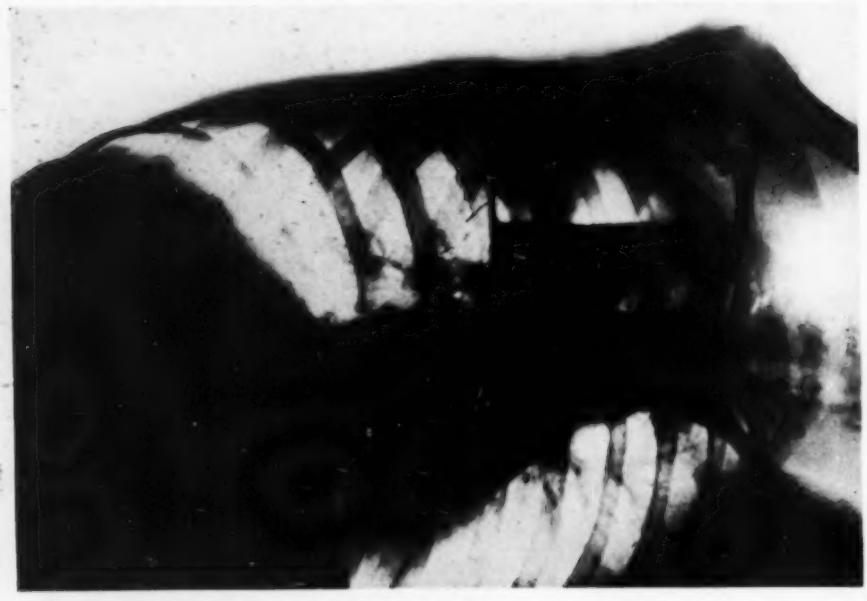

FIG. 2.—Case I. Lateral recumbent X-ray showing the fluid level.

When a fistula has developed, a number of factors may contribute to cause its persistence. Probably the most important is suppuration in the parenchyma of the lung or in the bronchial tree. Wilensky assumes that in a small number of cases the constant presence of low-grade infection in the bronchial tree, with the superposition of repeated attacks of acute inflammation, furnishes an important cause for the constant reinfection of the fistulous tract and failure to heal. An aspirated foreign body or a retained drain may be responsible for the persistence of the fistula. Finally, less apparent factors may be operative; thus a large bronchial fistula which opens into a rigid-walled empyema cavity is peculiarly liable to persist.

The walls of the fistula itself may become sclerosed. The entire tract may become epithelialized and may eventually produce a bronchocutaneous channel.

To the use of Dakin's solution has been attributed the development of some fistulas (Heuer,[23] Stevens[40]). This is said to be especially likely in empyemas due to streptococcus infection in which the surface of the lung is

studded with miliary abscesses. Multiple bronchial fistulas occasionally occur, most often in bronchiectasis.

The diagnosis of bronchial fistula is, as a rule, self-evident. The sudden development of a profuse secretion from an empyema wound together with an increase in the severity of the cough should make one suspicious of the presence of a fistula. If such an opening exists, the irrigation of an empyema cavity with Dakin's solution causes a paroxysm of coughing and the tasting of the solution by the patient. In a larger fistula, the diagnosis is self-evident when air is heard to escape from the wound. This sound is continuous when the patient strains with the glottis closed. In doubtful cases, the diagnosis may be confirmed by X-rays following the injection of lipiodol into the thoracic wound.

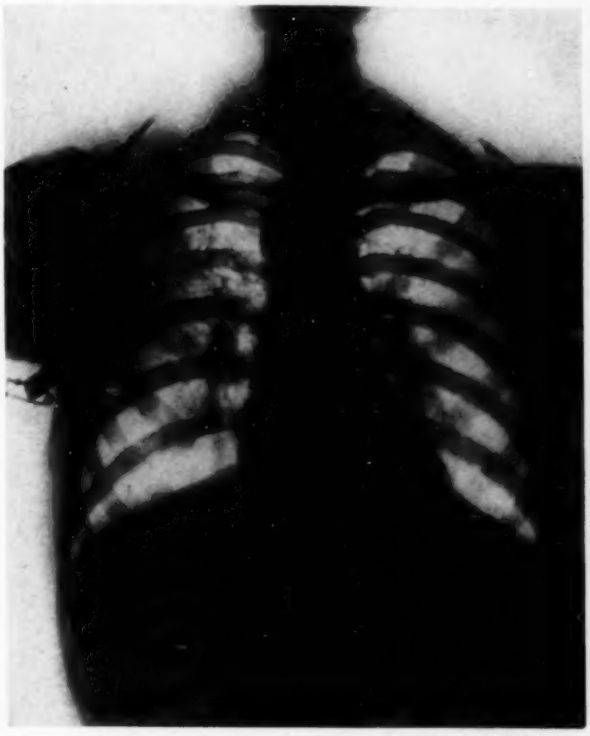

FIG. 3.—Case I. X-ray taken ten days following drainage of abscess.

Most bronchial fistulas will eventually close spontaneously if the underlying lung infection is cleared up. Neuhof [35] feels that this is practically always true. But, it must be emphasized that in many of the cases the processes of repair and closure occur only after a long period of time. Occasionally, a fistula persists indefinitely in spite of the subsidence of the underlying lung infection, especially where a large bronchial fistula opens into a chronic empyema cavity, or where a broncho-cutaneous fistula has formed. It is for such cases, particularly, that the operation to be described is suggested.

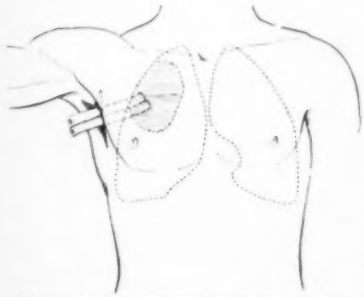

FIG. 4.—Diagrammatic sketch of location of abscess and drainage tubes in place. (From ANNALS OF SURGERY, March 1927.)

It is important before attempting to close a fistula, to verify the presence or absence of an underlying lung infection or a bronchiectasis by the history of the case, the clinical course, and by lipiodol injections. The pres-

ence or absence of a foreign body must be determined before instituting any treatment. Bronchoscopic removal of an aspirated foreign body or the removal of a lost drain by thoracotomy will very often result in rapid closure of the fistula.

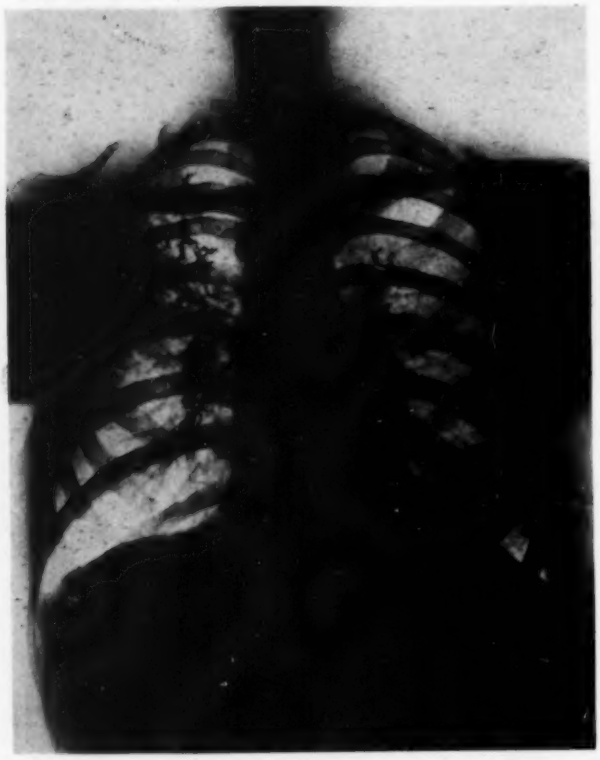

FIG. 5.—Case I. X-ray following injection of lipiodol into axillary sinus showing the presence of a bronchial communication.

Treatment.—The question of closing a bronchial fistula should only be considered after the need of drainage has passed; in other words, when the parenchyma of the lung is no longer acutely inflamed and in the absence of a bronchiectatic cavity. An empyema must be considered and treated as such independently of the fistula. If a bronchial fistula is closed in the presence of an active inflammatory process, an extensive acute pulmonary infection, or even embolic abscesses, for instance, in the brain, may occur.

Numerous methods have been recommended for the closure of bronchial fistulas. The simplest consists in the cauterization of the fistulous opening.

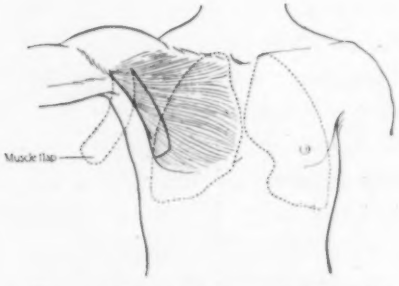

FIG. 6.—Case I. Diagrammatic sketch indicating outline of pedicled muscle flap taken from the pectoralis major muscle. (From ANNALS OF SURGERY, March, 1927.)

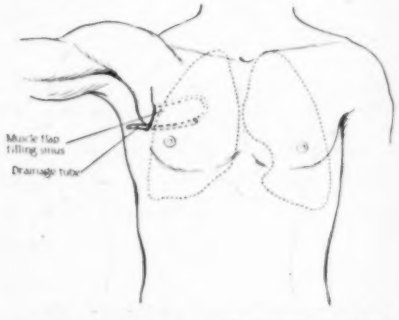

FIG. 7.—Case I. Diagrammatic sketch showing the insertion of the pedicled muscle flap into the cavity with a drainage tube placed beneath it. (From ANNALS OF SURGERY, March, 1927.)

The substances recommended have been numerous, the method usually consisting in local applications of the chemical or actual cauterizing agent to

the fistulous opening, the object of the treatment being to destroy the bronchial epithelium and to produce the formation of granulation tissue. In very small fistulas, this method is often successful. Keller [26] has obtained many closures with the use of gentian violet.

Other methods are based on the fact that many fistulas found in chronic empyema close spontaneously after mobilization of the lung or collapsing operations on the thoracic wall. This is undoubtedly true if the fistulas are small. With larger ones, however, spontaneous closure does not always occur. A striking example of this point is the second case reported in this paper. To close such fistulas, other methods have been employed, as purse-string sutures, or pedicled muscle or skin flaps placed *over the mouth* of the fistula. The insertion of purse-string sutures for the closure of bronchial fistulas is not a promising procedure, because the sutures are introduced in diseased tissue and tied under tension.

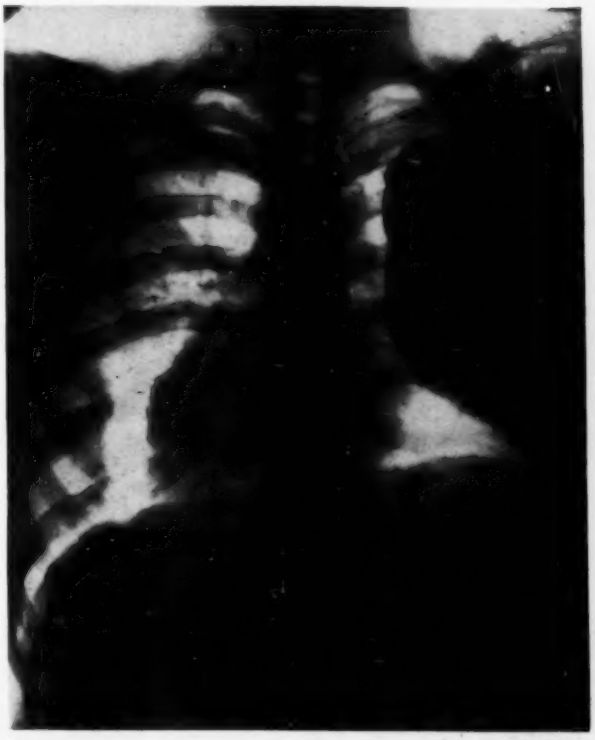

FIG. 8.—Case II. Anteroposterior X-ray following lipiodol injection showing the extent of the empyema cavity.

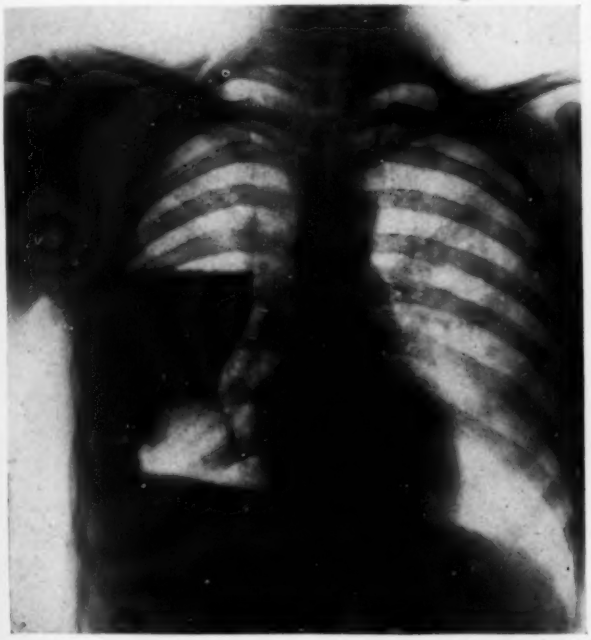

FIG. 9.—Case II. Anteroposterior X-ray following lipiodol injection with the cavity half filled, showing a prolongation of the cavity mesially.

Abrashanoff [1] in 1911 reported the use of a pedicled muscle flap placed *over the mouth* of

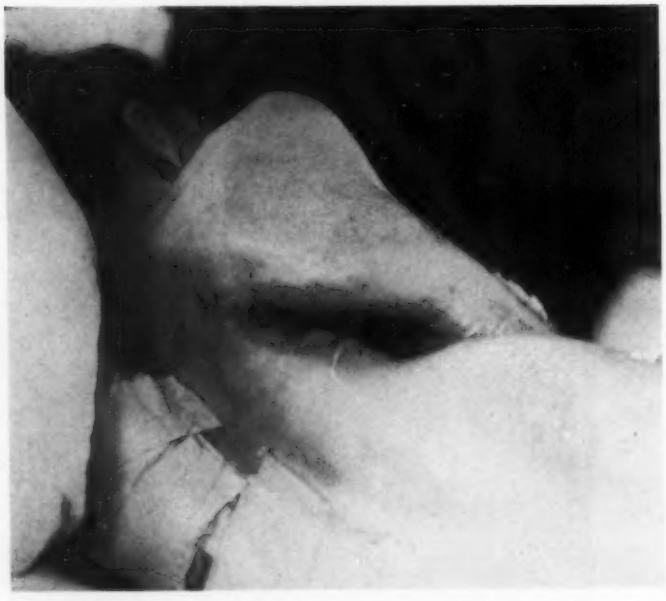

FIG. 10.—Case II. Indicates the appearance of the wound following one of the stages of a graded thoracoplasty. (From *American Journal of Surgery*, October, 1927.)

a bronchial fistula. Since that time, many surgeons have made use of this principle. The results have been fairly satisfactory. These operations have usually been performed in conjunction with decortication of the lung or collapse of the chest wall. Others have employed pedicled skin flaps in the same manner. Halstead and Thurston[18] reported the use of a combination of purse-string suture, a free graft of fascia and fat, and a pedunculated flap of skin and muscle. Others have recommended such radical procedures as cautery-pneumonectomy, and lobectomy; the real indication, however, for such procedures being the underlying diseased lung. A few writers have reported good results by the use of radium and Beck's paste.

We offer another method for the treatment of bronchial fistula. Its merits are its simplicity, its wide application, and its uniform success in our hands. As has been emphasized, any underlying parenchymal or bronchial infection or a

FIG. 11.—Case II. Shows the appearance of the wound before closure of the bronchial fistula. At the upper angle, one may see a dark area which indicates the position of the bronchial fistula. (From *American Journal of Surgery*, October, 1927.)

coëxisting empyema must be treated before operation for the closure of the fistula is attempted. The operation itself consists in the exposure of the fistula through an adequate incision without disturbing the relation of the lung to the chest wall, the fashioning of a pedicled muscle flap from neighboring muscle tissue, the insertion of the end of this flap *into the bronchus* as one inserts a cork into the neck of a bottle, the suture of the sides of the muscle flap to the tissues in the immediate neighborhood to prevent dislodgment, and finally, closure of the operative wound. This procedure has been carried out in three cases, which illustrate different types in which the method may be employed; we report their histories in detail.

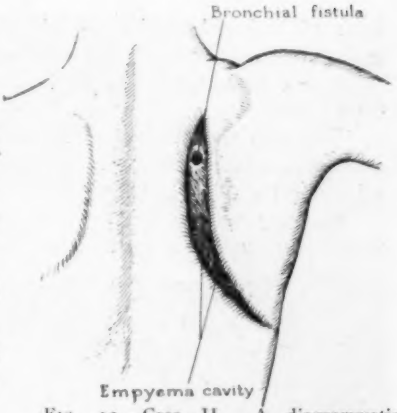

FIG. 12.—Case II. A diagrammatic sketch of the appearance of the wound before the closure of the bronchial fistula.

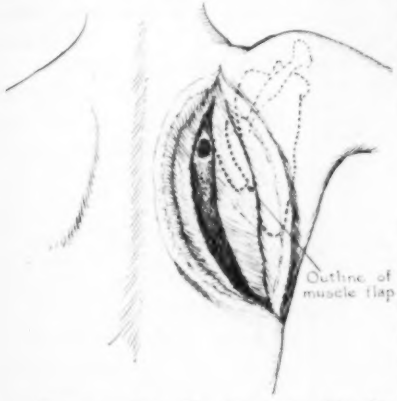

FIG. 13.—Case II. An outer skin flap has been dissected from the underlying musculature and a pedicled muscle flap has been fashioned.

REPORT OF CASES

CASE I.*—P. S., male, twenty-six years of age, was first admitted to the Medical Ward of the New York Hospital in August, 1911, with a diagnosis of incipient tuberculosis. He had physical signs at the right apex, but repeated sputum examinations were negative. Following tonsillectomy soon afterward, all his symptoms cleared up.

He was readmitted January 19, 1926, with the signs and symptoms of a large lung abscess of about three weeks' duration. The amount of sputum expectorated during twenty-four hours averaged eight ounces. The abscess was situated in the right upper lobe. (Figs. 1 and 2.) Repeated examinations of the sputum failed to reveal tubercle bacilli, but showed short-chain streptococci. White blood cells, 14,250, polymorphonuclear leucocytes, 68 per cent. The abscess was drained February 4, 1926. Under local anæsthesia, an incision was made in the right axilla. About two inches of the fourth and fifth ribs were removed. The abscess was found about one quarter of an inch from the periphery of the lung. Considerable fetid pus was evacuated. Two large rubber tubes were inserted for drainage. (Figs. 3 and 4.) A specimen of the lung excised at the time of this operation revealed, upon miscroscopic examination, a mass resembling mycelia with clear spore-like bodies. Occasional branched forms were seen. These masses resembled some

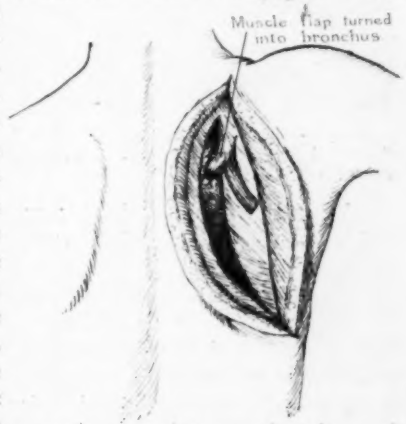

FIG. 14.—Case II. Diagrammatic sketch showing the muscle flap turned into the bronchial fistula as one would place a cork into the neck of a bottle.

* Reported in ANNALS OF SURGERY, March, 1927.

form of higher bacteria, possibly Aspergillus nodularis. Autopsy of a guinea pig injected with two cubic centimetres of the pus showed no lesions.

The convalescence was uneventful. Repeated sputum examinations were negative for tuberculosis.

The man was readmitted April 26, 1926, with a persistent sinus which communicated with a bronchus. X-ray examination after lipiodol injection into the sinus showed a bronchial fistula. (Fig. 5.)

On May 3, 1926, an operation for closure of the fistula was performed. The skin around the sinus was excised and newly-formed bone encircling the opening into the thorax removed. The cavity was about the length of the index finger. Its walls were soft and somewhat friable, and the cavity measured about two centimetres in diameter. The incision was extended along the lower margin of the pectoralis major muscle. A strip of muscle about twice as thick as the cavity, and four and a half inches in length, was dissected free, leaving its upper end attached. (Fig. 6.) This pedunculated flap was then turned into the cavity (Fig. 7) and fixed by two chromic sutures at the outlet. A small rubber tube was placed along the flap to the bottom of the cavity to prevent retention. The wound was sutured except at its central portion, which was packed with gauze. Ethylene anæsthesia; time, twenty-eight minutes. There was no cough after operation, and the wound healed rapidly. The tube was gradually shortened, and was removed on the fifth postoperative day.

FIG. 15.—Case II. Photograph taken fourteen days following closure of the empyema wound. (From *American Journal of Surgery*, October, 1927.)

When last seen, March 31, 1929, the patient stated he had gained thirty-five pounds and had no complaints. He is working regularly. X-ray examination shows no abnormality of the lung.

CASE II.†—E. K., male, twenty-four years of age, was first admitted to the Medical Ward of the New York Hospital, May 3, 1925, with a right lower lobar pneumonia. This was followed by an empyema which, upon aspiration, cultured streptococcus hemolyticus. The patient was transferred to the Second Surgical Division, and May 16, 1925, a rib resection was performed under local anæsthesia. Two rubber tube drains were inserted and the cavity was later dakinized. Convalescence was uneventful, and the patient was discharged July 1, 1925, to the country, with a small wound draining a small amount of fluid.

† Reported in *American Journal of Surgery*, October, 1927.

He was readmitted July 13, 1925, with the history that he had begun to have fever and increased discharge from the sinus. There was no evidence of encapsulated fluid. On two occasions, the sinus was enlarged. It was evident that there was a large chronic empyema cavity. As the patient was in rather poor condition, two transfusions were given. He was discharged October 4, 1925, to the country, with the recommendation that after his general condition had improved, he was to return for obliteration of the cavity.

He was readmitted May 6, 1926. The cavity had a capacity of sixteen ounces. (Figs. 8 and 9.) X-ray after lipiodol injection showed an extensive empyema cavity. Because his general condition was only fair, it was decided

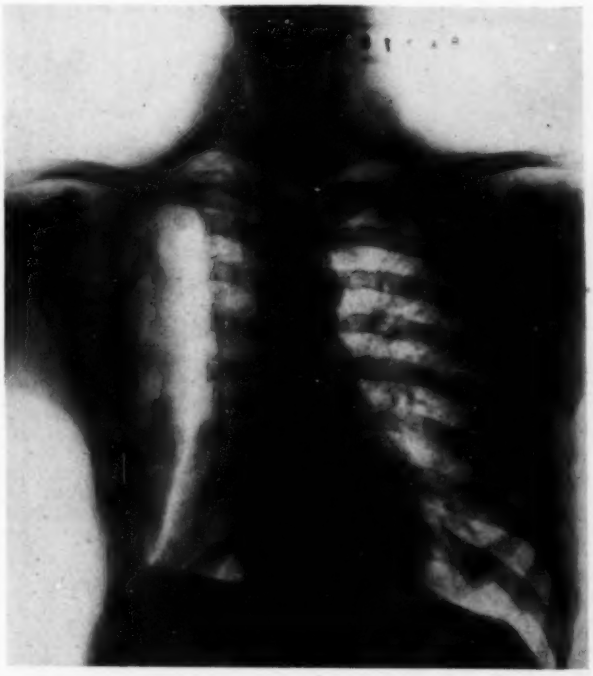

FIG. 16.—Case II. X-ray following closure of the empyema wound showing the layer of air between the visceral pleura and the overlying chest wall.

FIG. 17.—Case II. X-ray three months later indicating the absorption of the air noted in Fig. 16.

to employ a graded thoracoplasty after the method of Keller. The stages of this procedure were performed May 11, May 22, June 8, and June 24, 1926, and entailed the removal of sections of the tenth, ninth, eighth, seventh, sixth, fifth, fourth, and third ribs. (Figs. 10 and 11.) Between the various stages, the Carrel-Dakin treatment of the wound was used. Following the last operation, there was seen at the upper end of the cavity a large broncho-pleural fistula, measuring two centimetres in diameter. During the subsequent ten days, the entire cavity was packed with gauze saturated with 2.5 per cent. alcoholic solution of gentian violet. The wound was then dakinized and, on successive dressings, it was seen that the superficial lay-

FIG. 18.—Case III. Indicating the appearance of the wound before operation for the closure of the fistula.

tured to the rim of the opening with interrupted chromic catgut stitches. The visceral pleura was then subjected to discission after the method of Ransohoff. The wound was packed. Ethylene anæthesia; time, twenty minutes. There was no coughing during convalescence. The fistula remained closed, *the muscle uniting by primary union.* Following the decortication, considerable expansion of the lung was noted.

The cavity was then dakinized and after obtaining six successive negative cultures, was closed on September 1, 1926. At this operation, the two skin flaps were well mobilized, the various muscle flaps were freed and sutured together across the cavity, followed by closure of the skin. Two long rubber tube drains were placed between the muscle planes.

ers of the thickened visceral pleura peeled off readily. However, extensive dakinization failed to sterilize the cavity and it was felt that the presence of this large bronchial fistula was the cause of failure.

July 17, 1926, the following operation for the closure of the fistula was performed. The skin flap on the outer side of the wound was dissected free and a flap of muscle, somewhat larger in diameter than the size of the fistula, was dissected from the muscles mesial to the scapula. (Figs. 12 and 13.) The edges of the bronchial fistula were freshened with a curette and the pedicled muscle flap was turned *into* the fistula for a distance of one inch, so as to plug the bronchus. (Fig. 14.) It was su-

FIG. 19.—Case III. X-ray following injection of lipiodol into the thoracotomy wound, showing the outline of a large branch of the left lower bronchus.

These were removed in forty-eight hours. The wound healed by primary union and the patient was discharged from the hospital eighteen days later. (Figs. 15 and 16.)

When last seen, February 17, 1929, the patient said he had gained thirty pounds in weight, had returned to his former occupation and had no symptoms referable to his cardio-respiratory system. (Fig. 17.)

Case III.—N. H., girl, thirteen years of age, was first admitted to the Medical Ward of the New York Hospital because of persistent cough, with pain in the left lower chest, of two weeks' duration. This had occurred one week after recovery from a three weeks' illness with pneumonia. Physical examination showed a moderately ill, well-developed and well-nourished girl. Temperature 103° F., white blood cells, 22,250, polymorphonuclear leucocytes 87 per cent., hæmoglobin 74 per cent. Physical examination, confirmed by X-ray, gave the signs of fluid in the left chest. Upon aspiration, purulent material was obtained which cultured Pfeiffer's bacillus. The patient was transferred to the Second Surgical Division and on July 3, 1928, a rib resection was performed. Two rubber tubes were inserted.

Fig. 20.—Case III. Lateral view of the same condition noted in Fig. 19.

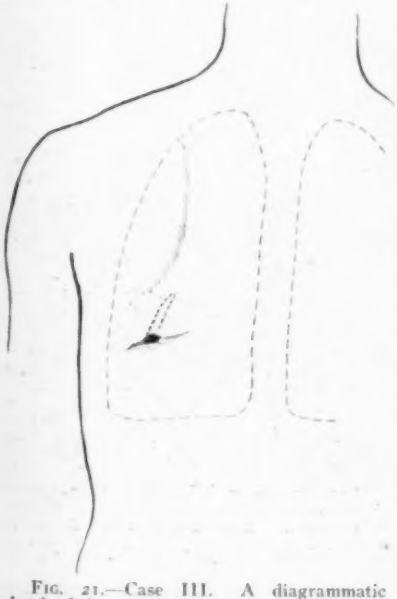

Fig. 21.—Case III. A diagrammatic sketch of the appearance of the wound before closure of fistula.

After operation, convalescence was smooth, except for the fact that the wound continued to drain profusely. On the twentieth post-operative day, it was noticed that irrigation of the wound with saline solution caused severe coughing, and that the patient tasted the salt. She was discharged on the forty-fourth post-operative day with a small granulating sinus and a definite bronchial fistula.

The patient was treated at the Out-Patient Department until September 21, 1928, without any decrease in the discharge from the wound, or tendency to closure of the fistula.

She was readmitted September 21, 1928. Examination at this time showed a granulating

sinus in the centre of the thoracotomy wound which extended inward for about one and a half inches. (Fig. 18.) X-ray after injection of lipiodol showed a bronchial fistula involving a large branch of the lower left main bronchus. (Figs. 19 and 20.) The thoracotomy wound was enlarged October 2, 1928, and there was found a large bronchial fistula adherent to the chest wall. The wound was dressed repeatedly until it became fairly clean. Because of the persistent cough and the failure

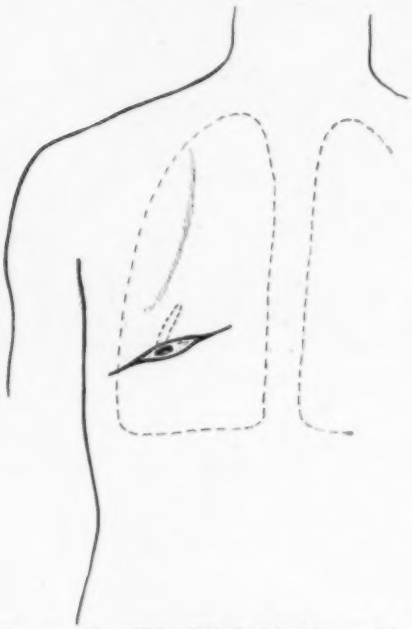

FIG. 22.—Case III. Elliptical incision excising the scar of the former operation.

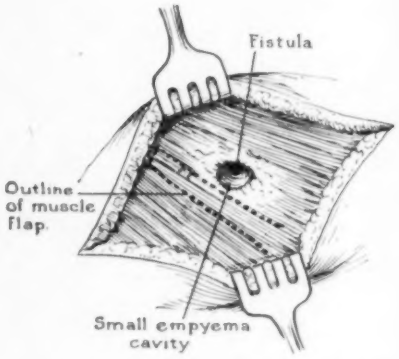

FIG. 23.—Case III. Indicating the outline of the muscle flap to be placed into the fistula. The small empyema cavity is indicated.

of the fistula to close spontaneously, operative closure was decided upon.

October 22, 1928, the following operation was performed: An elliptical excision of

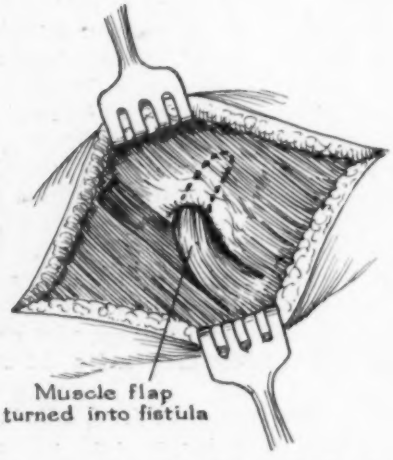

FIG. 24.—Case III. The muscle flap has been inserted into the bronchial fistula.

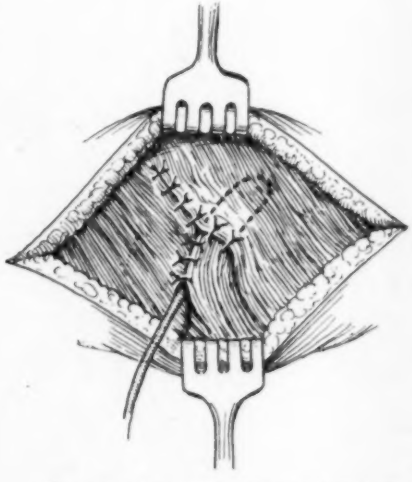

FIG. 25.—Case III. Sutures have been placed anchoring the muscle flap to prevent dislodgment. The small tube drain is indicated.

the previous scar was made (Figs. 21 and 22.) Upper and lower skin flaps were fashioned. The latissimus dorsi muscle was then isolated. An empyema cavity measuring

FIG. 26.—Case III. Appearance of wound eighteen days following closure of the bronchial fistula.

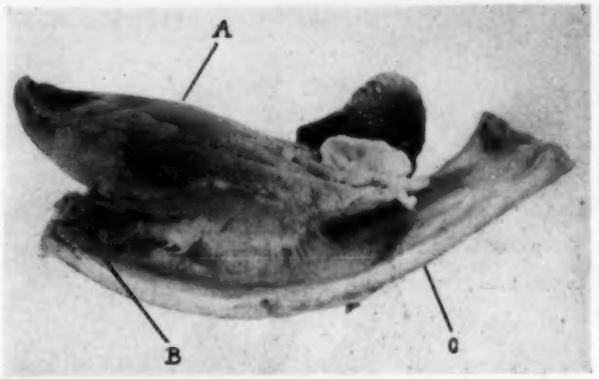

FIG. 27.—Experiment 8 described in protocols. Gross specimen showing lobe of lung adherent to the parietal pleura. The adjacent ribs are included. *A*—Lobe of lung. *B*—Parietal pleura. *C*—Ribs.

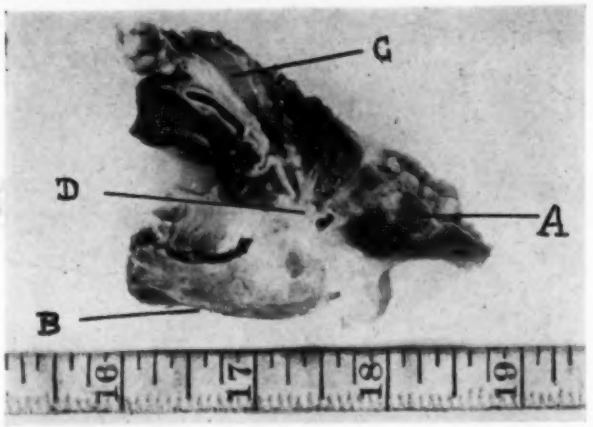

FIG. 28.—Experiment 8. Longitudinal section through the specimen pictured in Fig. 27 after removal of the ribs and excess lung tissue. One may note the pedicled muscle flap, the lobe of the lung, and a large bronchus cut longitudinally and again transversely. The muscle flap may be seen within the lumen of the bronchus. *A*—Lobe of lung. *B*—Pedicled muscle flap. *C*—Bronchus. *D*—Muscle flap in bronchus.

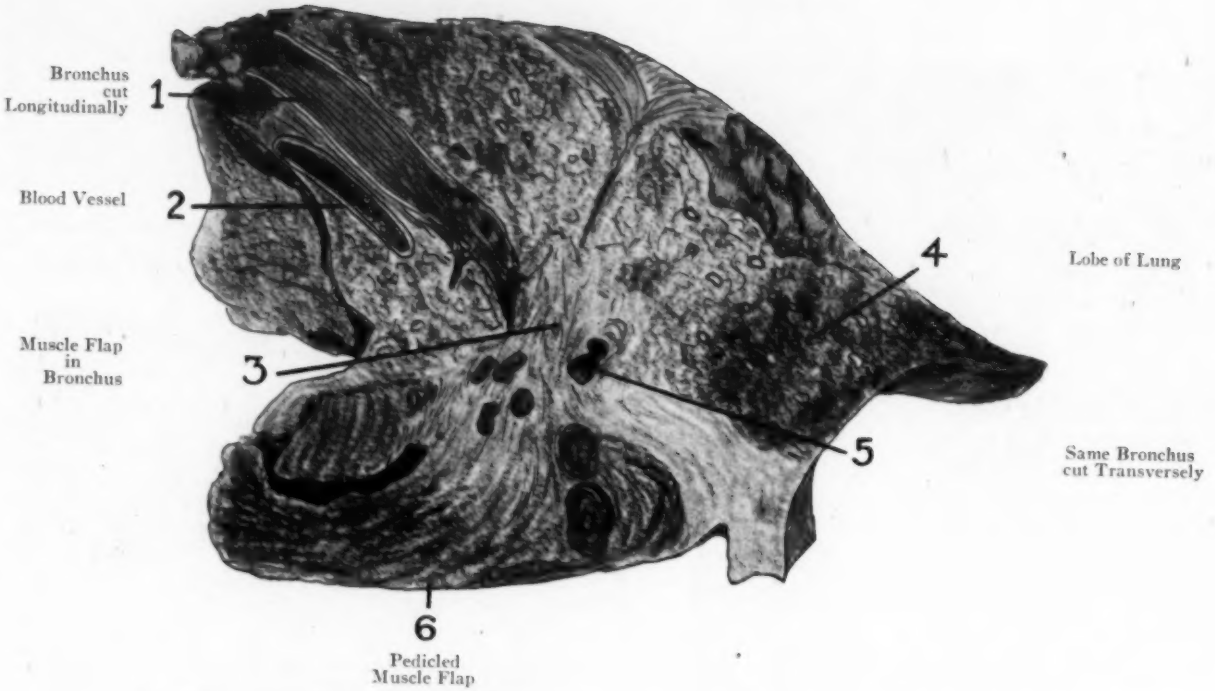

FIG. 29.—A diagrammatic sketch of the gross specimen pictured in Fig. 28, showing the muscle flap in the lumen of the bronchus.

one centimetre in diameter was visualized. At its mesial and upper aspect was a broncho-pleural fistula measuring about one centimetre in diameter. (Fig. 23.) A pedunculated muscle flap taken from the latissimus dorsi was then fashioned. (Fig. 24.) It was longitudinally bisected. The smaller segment was implanted *into* the fistula for a distance of about half an inch, and the latter one into the empyema cavity. The muscle flap was sutured to the surrounding muscular and fascial tissue. (Fig. 25.) Coughing did not cause extrusion of the flap. A tiny rubber tube drain was placed down to the empyema cavity behind the flap and the wound was closed with plain catgut for the deeper structures and silkworm gut for the skin. Ethylene anæsthesia; time, twenty minutes. The arm was immobilized to the side. The tube was removed on the fourth post-operative day. Convalescence was uneventful and the wound healed by primary union. (Fig. 26.) The unusual part of the convalescence was that, following operation, the patient did not cough once, although no sedatives were administered.

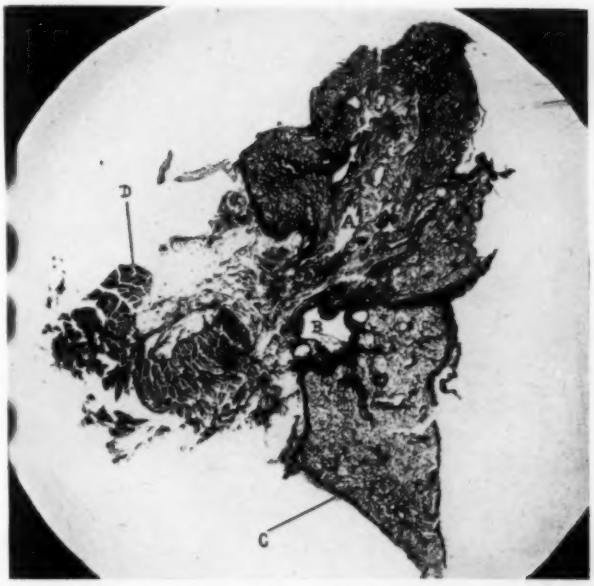

FIG. 30.—Microscopic section of the entire specimen pictured in Fig. 29. (Magnification x 2½.) The pedicled muscle flap enters into the bronchus which has been cut longitudinally at one point, *A*, and transversely, *B*, at another. Beyond is seen lung parenchyma. *C*—Lobe of lung. *D*—Muscle flap.

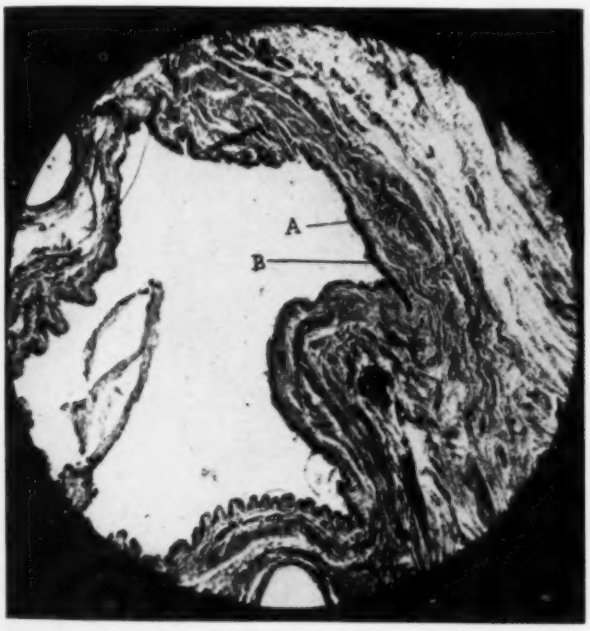

FIG. 31.—Microscopic section (magnified x 15) of transverse section of the bronchus, *B*, seen in Fig. 30. In this section may be seen the intact striated muscle fibres of the muscle flap over which has grown the bronchial epithelium. There is a moderate amount of fibrosis. *A*—Striated muscle fibres. *B*—Bronchial mucosa.

When last seen, April 7, 1929, the patient had gained fourteen pounds, had returned to school, and had had no symptoms referable to her former condition.

EXPERIMENTAL DATA ‡

In order to determine what happens following the performance of such an operation, and to study

‡ From the Surgical Research Laboratories, College of Physicians and Surgeons, Columbia University, Dr. William C. Clarke, Director.

FIG. 32.—Another view of the longitudinal section of the bronchus, *A*, pictured in Fig. 30 (magnified x 15) showing the intact striated fibres of the muscle flap and the outgrowth of bronchial mucous membrane, which has not yet completely covered the flap. The bronchial cartilages are visible. *A*—Muscle fibres. *B*—Bronchial mucosa. *C*—Bronchial cartilage.

the processes of repair, experiments on dogs were undertaken. It was felt that an attempt should be made to simulate, as closely as possible, the conditions found in man with lung or pleural suppuration. From this standpoint, however, the results were disappointing. We were unable to produce chronic pulmonary or pleural suppuration. We were able, however, to determine what happens to a muscle flap which has been plugged into a bronchus. In the beginning, the idea was to produce a lung abscess, to be followed by drainage with the production of a bronchial fistula. Accordingly, fourteen dogs were subjected to the method of Cutler, Schlueter and Weidlein. We tried to follow their technic in detail, but failed to obtain a single instance of lung abscess. This may be attributed to the fact that, although numerous strains of various organisms were used, we did not employ organisms pathogenic for the dog.

The experimental production of an empyema in the dog is quite easy, but because of the high mortality rate and the fact that the production of a bronchial fistula under these conditions was not feasible, this par-

FIG. 33.—A higher power microscopic section (magnified x 90) of the bronchus pictured in Fig. 31, showing the intact striated muscle fibres and the complete regeneration of the bronchial mucosa. *A*—Muscle fibres. *B*—Bronchial mucous membrane.

ticular method was abandoned.

After numerous unsuccessful attempts, a method for the artificial formation of a bronchial fistula was finally evolved. It may be stated incidentally, that it is extremely difficult to produce a bronchial fistula in an experimental animal because of the small size of the bronchial tree, the resulting shock when the pleural cavity is opened, and in view of the fact that experimental animals, especially dogs, rapidly heal any artificially produced pathological lesions.

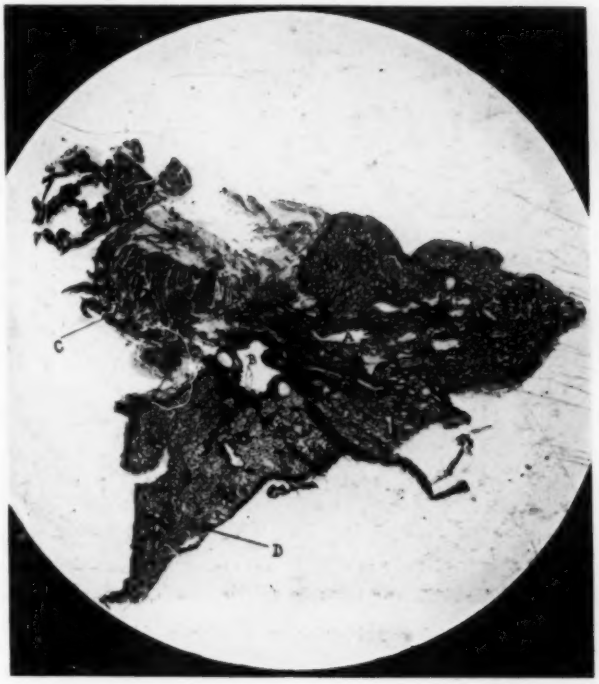

FIG. 34.—Microscopic section cut at a deeper level than that pictured in Fig. 30. The pedicled muscle flap within the lumen of the bronchus is clearly outlined. (Magnification x 2½.) *A*—Bronchus cut longitudinally. *B*—Same bronchus cut transversely. *C*—Muscle flap. *D*—Lobe of lung.

The operative procedure finally adopted was as follows: The animal was anæsthetized with ether. The entire left side of the chest wall was carefully prepared by shaving, scrubbing with alcohol and ether, and painting with 3.5 per cent. tincture of iodine. An oblique incision about five inches in length was made along the course of the sixth rib in the posterior axillary line. The overlying muscles were retracted. The sixth rib was then exposed and removed for a distance of three inches subperiosteally. Its encircling periosteum and the adjacent

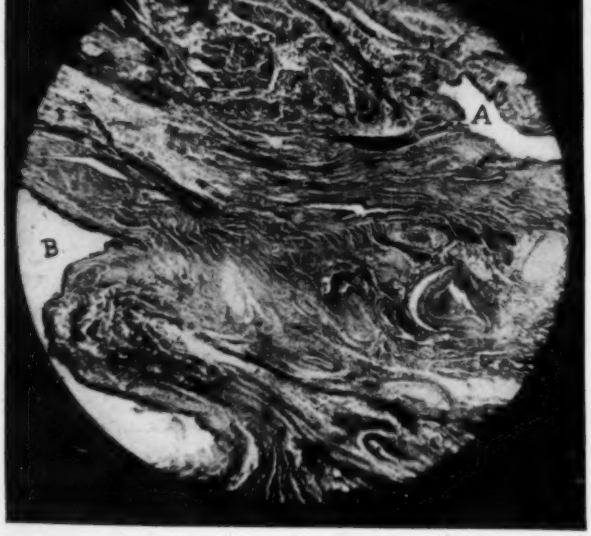

FIG. 35.—Microscopic section of higher magnification, x 15, including bronchus *A* and *B* and muscle flap, pictured in Fig. 34. This shows both sides of the sectioned bronchus with the muscle flap between. The viability of the muscle fibres is noteworthy.

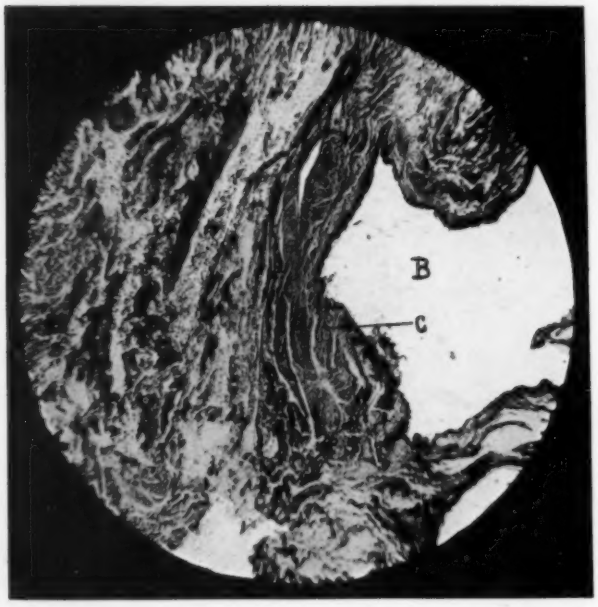

FIG. 36.—High magnification, x 90, of one side of the bronchus, *B*, noted in Fig. 35. The growth of bronchial mucosa over the muscle flap is here clearly demonstrated. *C*—Striated muscle fibres.

intercostal muscles were then very carefully dissected from the parietal pleura and excised, a procedure involving great care because of the ease with which the extremely thin parietal pleura may be perforated. Through the thin pleura can be seen the underlying expanded lung. Using a very fine curved needle and fine silk, stitches were taken in a circumferential manner in such a way as to catch both pleura and lung in each bite. By this method, a lobe of the lung can be sutured to the parietal pleura without producing a pneumothorax. After inserting ten or twelve sutures, involving a surface of the lung approximately one and a quarter inches in diameter, the overlying pleura was excised and the wound was closed by replacing the retracted muscles. The skin and subcutaneous tissues were sutured with fine silk so as to produce eversion of the skin edges. A cotton-collodion dressing was applied followed by a chest bandage and the application of a canvas jacket.

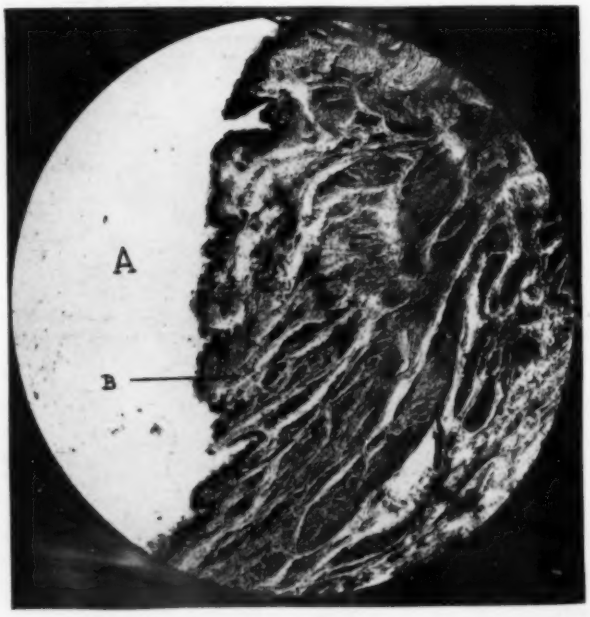

FIG. 37.—High magnification, x 90, of the other side of the bronchus, *A*, pictured in Fig. 35, showing the distribution of the striated fibres of the muscle flap covered by bronchial mucosa. The scarcity of fibrous tissue formation is especially noteworthy. *A*—Bronchus. *B*—Muscle fibres.

Two weeks later a second operation was performed. After careful skin preparation, the scar

FIG. 38.—Experiment 10 described in protocols. Gross specimen of lobe of lung adherent to the parietal pleura with the adjacent ribs. *A*—Lobe of lung. *B*—Ribs.

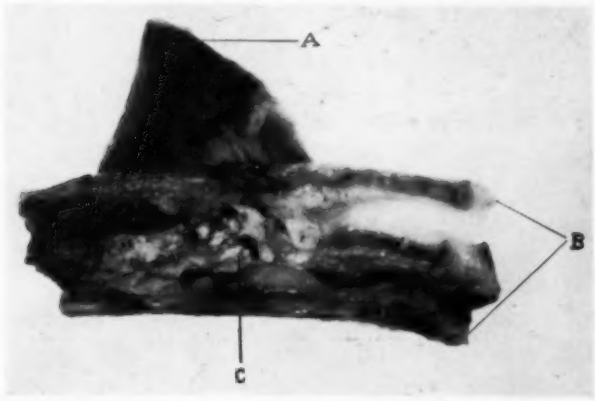

FIG. 39.—Another view of the specimen pictured in Fig. 38, showing the external surfaces of three ribs with the pedicled muscle flap. *A*—Lobe of lung. *B*—Ribs. *C*—Pedicled muscle flap.

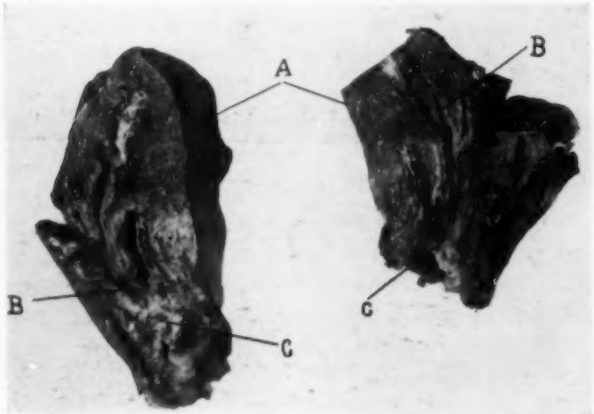

FIG. 40.—Longitudinal section of gross specimen pictured in Figs. 38 and 39, after removal of the ribs and excess lung tissue. Here one may see a large bronchus cut longitudinally, surrounding lung tissue, and at the lower pole the pedicled muscle flap over which there has been a growth of bronchial mucosa. *A*—Lung. B—Bronchus cut longitudinally. C—Muscle flap.

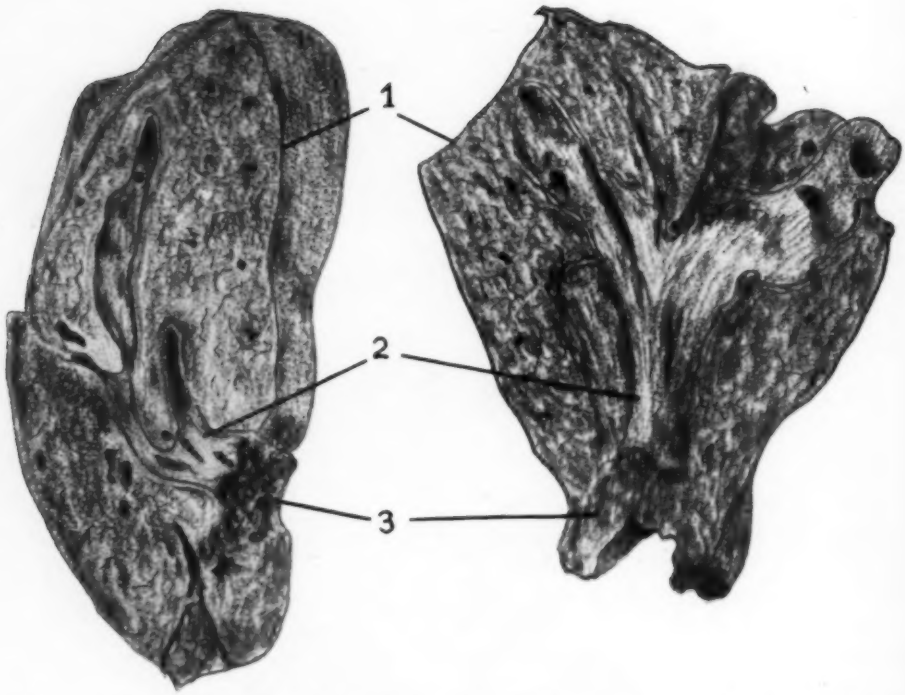

FIG. 41.—Diagrammatic sketch of the specimen pictured in Fig. 40, to clarify the details of the various components. 1—Lobe of lung. 2—Bronchus cut longitudinally. 3—Muscle flap in bronchus.

of the former operation was excised. The overlying musculature was again retracted, exposing the lobe of the lung adherent to the parietal pleura at the rim of the opening. By blunt dissection an opening was carefully made into the substance of the lung and extended deeper and deeper until a fair size bronchus was encountered. Not infrequently, a large pulmonary vessel simulates closely the appearance of a bronchus. Therefore, in each instance, a fine aspirating needle was inserted to determine the contents of the structure isolated. When satisfied that the structure was a bronchus, stay sutures of fine silk were inserted and an opening made into it. By dissecting this structure from its surrounding lung parenchyma, considerable mobilization was obtained. A bronchocutaneous fistula was then formed by suturing the previously mobilized skin flaps to the edges of the opening in the bronchus with fine silk. A sterile dressing was then applied and held in place by bandage and a canvas jacket.

During the following ten days the wound was dressed daily. At each dressing, bronchial secretion which tended to occlude the opening was carefully wiped away. Every other day during this period the bronchus was cauterized with carbolic acid followed by alcohol. The purpose of this procedure was to cause a denudation of the bronchial mucosa. It was necessary to perform the final stage within the ten-day period in order to prevent the spontaneous closure of the fistula.

At this last operation, the scar was excised and the skin separated from the adherent bronchial opening which, by this time, had become fairly well fixed near the periphery of the lung. A pedunculated flap of muscle, corresponding to the size of the fistula, was then fashioned from the latissimus dorsi muscle which had been previously preserved intact. This flap was tubularized by approximating the lateral edges with fine plain catgut sutures. It was then placed deeply *into the bronchus* for a distance of one-half to three-quarters of an inch and held in place by fine catgut stitches placed in the muscle and the rim of the fistula. The remainder of the muscle flap was anchored to the surrounding structures with silk sutures so as to avoid strain on the flap when the animal was up and about. The remainder of the wound was then closed without drainage, care being taken to obliterate all dead spaces. A sterile dressing and canvas jacket were then applied.

While this procedure was carried out in ten dogs, in only two were satisfactory specimens obtained. These dogs lived ten months and one year respectively. Their protocols are herewith appended:

PROTOCOLS

Experiment 8.—No. 9499, female collie. *First stage operation,* December 22, 1927. Ether anæsthesia. Left chest wall prepared as above described. Three inches of the fifth rib excised through an oblique incision. Intercostal muscles and periosteum dissected from parietal pleura and excised, leaving an opening about one and a quarter inches in diameter. Interrupted sutures of fine silk were then placed circumferentially, uniting lobe of lung to the parietal pleura. The overlying retracted muscles were then replaced and the skin closed with silk.

Second stage operation, February 1, 1928. The scar of the former operation was excised. Overlying muscles retracted, exposing adherent lobe of lung. By blunt dissection, a hole was made into the substance of the lung until a large bronchus was isolated. It was aspirated with a fine needle. Stay sutures of silk were inserted and an opening made into the bronchus, approximately three-eighths of an inch in diameter. The bronchus was mobilized by freeing it from its surrounding tissues and sutured to the edges of the skin flaps. The remainder of the wound was then closed with fine catgut for the muscles and silk for the skin.

February 2, 1928, wound dressed. Fistula patent. Bronchial secretion wiped away.

February 3, 1928, phenol and alcohol applied to fistula.

February 5, 1928, phenol and alcohol again applied to fistulous opening.

February 7, 1928, phenol and alcohol again applied.

Third stage operation, February 10, 1928. The scar of the previous operation was excised, freeing the skin edge from its attachment to the bronchial opening. Skin flaps were then fashioned and the latissimus dorsi muscle isolated. A pedunculated muscle flap was then freed and fashioned into a tube measuring about three-eighths of an inch in diameter. It was then turned *into* the bronchus for a distance of one-half inch and anchored to the rim of the bronchial opening with interrupted sutures of fine catgut. The remainder of the muscle flap was then anchored to the surrounding structures by inserting interrupted sutures of silk. All dead spaces were obliterated and the wound closed without drainage.

This animal was killed on February 1, 1929, one year after the last operation. At autopsy, the broad surface of the middle lobe of the left lung was found firmly adherent to the parietal pleura. After separation of the skin and subcutaneous tissues, the muscle flap was isolated. The entire specimen was excised for study. (Fig. 27.)

The adjoining ribs and excess muscle and lung tissue were removed. The plugged bronchus was then isolated by carefully opening the bronchial tree from the main bronchus as a starting point. When the occluded bronchus was seen, the specimen was bisected longitudinally at this point. The cut gross section is shown in Figures 28 and 29. It will be seen that the main portion of the bronchus has been cut longitudinally. Entering into the bronchus is a small muscle flap, and below this point the same bronchus has been cut transversely. The muscle flap was found firmly united to the wall of the bronchus, and, in the gross, there was evidence of the outgrowth of bronchial epithelium to cover the muscle flap. There was little to indicate inflammatory reaction in the adjacent lung parenchyma.

Microscopic sections of the entire cut surface were then made. (Figs. 30, 31, 32, 33, 34, 35, 36, 37.) Dr. Gilbert Dalldorf of the pathological department, at New York Hospital, has kindly examined these sections and his report follows: "The specimen is an equilateral triangle, about four centimetres on each side. The lower part is lung parenchyma and a transverse line separates this from the triangular mass of muscle tissue. At about its mid-point the muscle tissue is seen to enter a distended bronchiole which appears distorted. The muscle is largely intact, but in places, alternates with fibrous tissue. Although the relationship between this bronchiole and the smaller ones is asymmetric and unnatural, all of these structures, however, are normal in the sense that their walls are intact and lined with tall columnar epithelium. The bronchiole which contains the muscle is distended, the lumen measuring roughly three by four millimetres. There is practically no inflammatory reaction either in the lung or the muscle flap. With the operative procedure as described, it seems reasonable to assume from examination of the specimen, that there has been a growth of bronchial epithelium over the sides of the muscle flap lying within the lumen of the bronchus."

Experiment 10.—No. 9731. Male Irish terrier. *First stage operation,* February 28, 1928. Ether anæsthesia. Left chest wall prepared as above described. An operation identical with the one described under Experiment 8 was performed.

Second stage operation, March 9, 1928.—The scar of the former operation was

excised and the adherent lung visualized by retraction of the overlying muscles. A hole was then made bluntly into the substance of the lung until a large bronchus was isolated. This bronchus ran in a somewhat vertical direction. After mobilization from the surrounding lung parenchyma, stay sutures were applied and the bronchus drawn up into the wound, thus creating a Y formation. The edges of the opening in the bronchus, which measured three-eighths of an inch, were sutured to the edges of the skin flaps with silk. The remainder of the wound was closed as above described.

March 10, 1928, wound dressed. Bronchial secretion which tended to plug the opening removed, reëstablishing a flow of air.

March 12, 1928, bronchial secretion removed. Carbolic acid and alcohol applied to the fistula.

March 14, 1928, phenol and alcohol again applied. Fistula patent.

March 16, 1928, phenol and alcohol again applied. Strong flow of air noted.

Third stage operation, March 18, 1928. The scar of the previous operation was excised, liberating the skin edge from its attachment to the bronchial opening. Skin flaps were then dissected and the latissimus dorsi muscle isolated. A pedunculated muscle flap was then formed and split longitudinally. Each segment of the split flap was then rolled into a tube and inserted into the two limbs of the Y-shaped fistula. The flap was then anchored to the rim of the fistula with fine catgut. The remainder was sutured to the surrounding structures to prevent dislodgment. All dead spaces were obliterated and the wound closed without drainage.

This animal was killed on December 26, 1928. At autopsy, the broad surface of the middle lobe of the left lung was found firmly adherent to the parietal pleura. The adjacent ribs, the lobe of the lung, and the overlying musculature were excised *en masse* for study. (Figs. 38 and 39.)

The adjacent ribs and the excess lung and muscle tissue were excised. The plugged bronchus was isolated by careful dissection of the bronchial tree from its origin. When this point was reached, the entire specimen was bisected longitudinally. The gross cut section is shown in Figures 40 and 41. It will be seen that the bronchus has been divided longitudinally. At its lower extremity is a section of the muscle flap which lies firmly united to the interior of the bronchus at this point. In the gross, the outgrowth of bronchial epithelium to cover the surface of the muscle flap is clearly indicated. There is no evidence of inflammatory reaction in the lung parenchyma.

CONCLUSIONS

1. Bronchial fistulas occur most commonly with empyema thoracis and lung abscess.

2. The majority close spontaneously.

3. Persistence of a fistula may be due to suppuration in the parenchyma of the lung or the bronchial tree, the presence of a rigid-walled empyema cavity into which the fistula opens, the formation of a broncho-cutaneous channel or the presence of a foreign body.

4. Operative closure of a bronchial fistula should not be attempted until the need for drainage of a lung suppuration has passed.

5. Very small fistulas will frequently close following the local application of some cauterizing agent.

6. For the closure of a bronchial fistula which persists in spite of conservative measures, an operative procedure is described. This consists in plugging the fistula with a pedunculated muscle flap. The operation is simple, of wide application, and has proved successful in our experience.

7. The production of a bronchial fistula in an experimental animal is attended with great technical difficulties.

8. Although the experimental data herewith reported do not duplicate exactly conditions as found in man, the results obtained indicate clearly the processes of repair following closure of a bronchial fistula by the method described.

9. A muscle flap placed into a bronchial fistula to effect its closure remains viable and is not completely replaced by fibrous tissue. Microscopic examination shows intact muscle fibres at the end of a year.

10. The sections further disclose the growth of bronchial epithelium over the muscle flap.

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SUBPHRENIC ABSCESS *

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Since Barlow's original paper, published in the *London Medical Gazette* in May, 1845, describing subphrenic abscess the condition has been occasionally mentioned in medical literature, but no great interest appears to have existed until Leyden, in 1880, described the disease, its symptoms and signs. Since that time the pathology, signs and symptoms have been described by many eminent writers. In the present paper I desire only to call attention to the more important phases of the subject.

In a general way one considers a subphrenic abscess as a localized inflammatory process in one of the many spaces of the upper abdomen between the diaphragm above and the transverse mesocolon below, while in reality a true subphrenic abscess is located between the domed surface of the liver below and the diaphragm above, but the latter classification would exclude many collections of pus which are generally known as subphrenic abscess. The liver and its coronary ligament divide this area into an anterior and posterior space. The upper part of the subphrenic space is further divided into a large right, and a small left, space by the suspensory or falciform ligament. The liver also divides this space into a suprahepatic and infrahepatic space. There is an extraperitoneal space which is situated between the folds of the ligaments of the liver. Some knowledge of these spaces is necessary in order to locate and properly treat an abscess in this locality.

The vast majority of abscesses occur in the right side, although one is occasionally found in the left side as a complication of a perforation of the stomach, or from pancreatic, splenic or renal infections. The germ most frequently found appears to be the colon bacillus, although it is not uncommon to find the streptococcus, staphylococcus, pneumococcus, pyocyaneus and rarely the Welsh or tubercle bacillus.

In a review of twenty-four cases of subphrenic abscess which I am able to find from the records of the Post-Graduate Hospital covering the years from 1914-1928, there are six cases of subphrenic abscesses complicating appendicitis, six cases complicating gall-bladder disease, four cases associated with pneumonia, empyema or pleurisy, two cases following perforated duodenal ulcers, two cases following trauma to the upper abdomen, of which one followed rupture of the liver, and the other a simple contusion of the upper abdomen with the development of an abscess which was opened thirteen days later. Of the remaining two cases, one case is reported as being due to exposure, and the other to abscess formation with actinomycosis of the right pleura and subphrenic space, apparently actinomycosis of the hepatic flexure of the colon with extension through the lymphatics of the diaphragm. For

* Read before the New York Surgical Society, March 27, 1929.

the reviews of these cases I am indebted to the visiting surgeons of the Post-Graduate Hospital.

Most authorities cite perforations of the pylorus and duodenum as the most frequent causes, and disease of the appendix as second in frequency. Trauma is rarely mentioned as a cause, yet in this small series it is thought to be responsible in two cases. A very frequent cause is the appendix which may produce either the intraperitoneal or extraperitoneal abscess. The infection travels up behind the colon from a retrocæcal appendix, or it may extend up the sides or in front of the ascending colon.

Peristaltic action of the colon is believed to aid in carrying the infection to the under surface of the diaphragm. Likewise, a perinephritic infection may spread upward, or an empyema of the chest may perforate the diaphragm, though it is more probable that a subdiaphragmatic infection may spread upward through the lymphatics of the diaphragm, especially on the right side, and be the cause of a prolonged empyema of the pleura.

General peritonitis from any cause may result in the formation of pus beneath the diaphragm, and I believe this to be the cause in the majority of these abscesses. The worst case I encountered occurred in a patient upon whom I operated for a suppurative pancreatitis associated with a gangrenous cholecystitis.

Rupture of an abscess of the liver was the cause in another case. Many cases thought to be abscesses of the liver may prove to be subphrenic abscess eventually.

Gas is sometimes found as well as pus in the abscess and denotes the presence of a perforation of a hollow viscus or a gas-producing infection such as the aërogenes capsulatus or the more frequent colon bacillus. The pus has a very foul odor in all the cases I have encountered. Subdiaphragmatic abscess may develop rapidly after an abdominal infection or it may be very insidious in its formation, occurring months, or possibly a year or more, after the original infection.

I believe it to be a more frequent condition than it is generally supposed and that numbers of small abscesses develop in this locality which are never recognized and which clear up without surgical intervention by absorption of the pus. Mechanical factors, due to anatomical position and vitality of the patient, favor spontaneous absorption. I have found small collections of pus high in the abdomen on the under and posterior surface of the liver in two cases upon which I have operated shortly after operations have been performed for cholecystitis. In neither case were there recognizable symptoms of the infection. In one of these cases I operated to remove a large stone in the lower end of the common duct eight weeks after the cholecystectomy had been performed and found fully two ounces of pus. The patient did not have elevation of temperature nor any symptom except recurring attacks of pain and marked jaundice from obstruction of the duct by a stone.

When symptoms of disease in the lower part of the chest or upper part of the abdomen appear following an acute or chronic abdominal disease we

should suspect subdiaphragmatic abscess. The symptoms are almost always associated with or closely resemble those found in diseases of the lower part of the thorax. The patient is septic, there is pain in the epigastrium, right or left hypochondrium or the lumbar region. More pronounced, in my own observation, in the lumbar region and referred upward between the scapulæ. Considerable emphasis has been laid on pain referred to the end of the twelfth rib. The pain is sharp and pleuritic in character and usually requires opiates to give relief.

In an abscess on the right side a perihepatitis is usually present; also there are râles in the lower chest. Rarely an associated pleurisy with effusion is found which makes the condition all the more difficult to diagnose. There is elevation of temperature, usually of the septic type, which begins sometime after the temperature from the abdominal disease causing the abscess has been normal.

The temperature may remain normal for months and the patient completely recovered from the former illness before there is sudden appearance of pain, elevation of temperature, leucocytosis, and other symptoms denoting a severe infection. This occurred in one of my own cases. During the month of March, 1921, I operated upon a patient, thirty-eight years of age, for a perforated duodenal ulcer. The patient made an uneventful recovery, gained forty pounds in weight and appeared to be perfectly well until the 25th of the following October, when he became ill with pain in the upper abdomen referred to the back, fever of the intermittent type and rapid loss of weight. I saw him on November 18, and operated upon him for a large subphrenic abscess.

In two of the twenty-four cases studied from the Post-Graduate Hospital series the abscesses developed in one case a year after pneumonia and pleurisy with effusion, and in the other seven years after an empyema operation without apparent later cause.

Paralysis of the diaphragm with depression of the liver may be an early symptom if the abscess is intraperitoneal. The liver does not move up and down freely with respiration and there may be jaundice or the so-called purulent complexion.

Differential diagnosis between subdiaphragmatic abscess and lung or pleural infections is most difficult. In abscess there is dulness on percussion in the lower part of the chest which may extend from the third rib anteriorly to Poupart's ligament. The dulness is higher in front and lower behind. The upper line of dulness is not as well defined as in pleurisy with effusion, and change in position of the patient does not effect the area of dulness. The chest movements are not impaired to the same extent as in pleurisy with effusion.

The heart is not displaced unless there is an associated pleurisy with effusion. If gas is present in the abscess there is dulness above the tympany found over the gas area. The presence of hiccoughs is highly suggestive of a diaphragmatic lesion.

Rapid breathing associated with cough and expectoration are not marked symptoms if present at all. There is usually rigidity with a sense of fulness in the upper abdomen either on the right or left side, and tenderness over the affected side is frequently seen.

When a subdiaphragmatic abscess is well developed the prognosis is grave. Most authorities quote the mortality rate from 20 to 50 per cent. This is a disease in which time is a vital factor, hence early recognition with proper treatment should, and no doubt will, lower the former high mortality rate.

For years it has been common practice to employ the aspirating needle in making the diagnosis. I am glad this practice is going out of fashion. I cannot lay sufficient emphasis on the futility of this custom. I have never been able to see any more reason for aspirating a suspected subphrenic abscess than for aspirating a suspected pelvic or appendix abscess, the practice of which has been abandoned for the past forty years. This use of the aspirating needle is condemned in almost every recent article I have been able to find upon this subject. It is, however, occasionally used and I think rightly so, to aspirate the pleural cavity when there are symptoms indicating fluid or pus in the pleura. Otherwise the use of the exploratory needle for lesions with vague anatomical locations should be abolished and replaced by the proper application of up-to-date X-ray methods, particularly when obtained by the coöperation of the röntgenologist and surgeon.

I have found X-rays to be of especial value in differentiating subphrenic abscess when, in addition to the usual anteroposterior view in the sitting and prone position, an exposure is made using as the centre of the focus the lateral border of the chest wall approximately on the level of the costophrenic sinus. An exposure made in this way will eliminate the possibility of the shadow of an abscess below the diaphragm pushing up this structure so as to obscure the costophrenic sinus. I recall a case in which numbers of aspirations of the pleural cavity had failed to find fluid when finally an X-ray was taken as described above which showed the lower pleura to be perfectly free of fluid. If the patient is too ill to sit up in the erect position for X-ray it is sometimes helpful to make an exposure with the patient lying on the side as suggested by Douglas.

I can see no objection to an abdominal exploration under local or spinal anæsthesia in a case of suspected subphrenic abscess.

In 1908 Dr. John W. Keefe, of Providence, read a paper before the twenty-first annual meeting of the American Association of Obstetricians and Gynæcologists, in which he strongly advocated the use of an exploratory abdominal incision in the epigastrium or through the right or left upper rectus muscle "to form a correct conception of the abnormal condition present and the altered position of the viscera".

I have watched Dr. John F. Erdmann employ this procedure for the past twenty years and have used it in all cases that I have operated upon myself with gratifying results.

The use of this incision certainly gives most valuable information as to

the best methods of opening and draining the abscess. When the abscess is located, if it is thought wise to drain through the abdomen the viscera are walled off with saline pads and great care is exercised to use suction to remove the pus without much spilling, which can be easily done by employing the ordinary suction tube such as is used by the laryngologist, rather than the ordinary instrument sometimes used for abdominal suction. Then a counter incision is made between the ribs in the lateral or posterior wall of the upper abdomen and through-and-through drainage instituted, or only the latter incisions may be used for drainage in which case the abdominal wound is closed. It is also possible in some cases to make an incision along the costal border down to the peritoneum, then strip the peritoneum down and enter the abscess extraperitoneally. I have recently employed this incision in opening a large abscess in a patient, sixty-eight years of age, who developed an abscess in the right subphrenic area three years after a primary operation for cholecystectomy. This patient drained bile and pus for a long time after the gall-bladder operation and finally healed, but was in poor health until the subphrenic abscess was drained October 23, 1928. The patient was discharged from the hospital November 5 with wound practically healed. It does not appear to me to be good surgery to make a routine practice of resection of the ribs for this condition in a patient who is already in a debilitated state, thereby adding additional shock which frequently results in death.

Some cases can be drained through an intercostal incision between the ninth, tenth or eleventh ribs if there is definite evidence that pus is present in the posterior space, but if this is done the simple intercostal incision is employed and a double rubber tube introduced into the abscess cavity until the patient's condition is improved, and it is rarely necessary to do a later resection of the ribs to get a sinus to heal.

I cannot see the necessity for opening the pleura for draining a subphrenic abscess. If an empyema is present the pleura is drained through the same incision puncturing the diaphragm or through a higher intercostal incision. Every authority who quotes statistics gives the highest mortality rate in operations in which the transpleural route has been employed.

CONCLUSIONS

1. Subdiaphragmatic abscess defies early accurate diagnosis insofar as the anatomical location and pathogenesis is concerned.

2. The customary use of the exploratory needle is misleading and dangerous.

3. Early recognition and proper surgical treatment should reduce the high mortality rate so far reported.

4. A broader and safer surgical measure is afforded by the transabdominal, than by the hazardous transpleural, route.

GONORRHŒAL INFECTION OF ABDOMINAL WOUNDS FOLLOWING LAPAROTOMY

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While metastatic suppurative processes may frequently be caused by the gonococcus, wound infection with this organism is one of the rare complications of gonorrhœa, and one which has received little attention in the literature. By nature especially adapted to serous and mucous surfaces, the gonococcus finds its usual habitat in the genito-urinary tract, the synovial membranes, and the conjunctiva. More rarely it is the cause of peritonitis, pericarditis, and endocarditis, and still more rarely is responsible for lesions of the muscles and skin.

The presence of the gonococcus in a wound was noted by Stephens[1] in a man of twenty-seven. This patient had gonorrhœa at the age of seventeen, but at the time of observation had no symptoms of the disease. He received a gunshot wound necessitating amputation of the right thigh. The day following this operation hot salt solution caused a second degree burn three inches in diameter on the left thigh. This lesion advanced to chronicity, showed undermining of the edges, was covered by thick yellow pus, and at eight weeks showed no tendency to heal. Smears from the lesion showed Gram-negative intracellular diplococci which failed to grow on plain agar, blood serum, and blood agar, but grew slowly on blood-streaked agar. The organisms failed to ferment glucose, but agglutinated with the serum from a known case of gonorrhœa. The wound rapidly improved under treatment with 10 per cent. silver nitrate and 10 per cent. silvol. In discussing the case Stephens states that the probable source of infection was through instruments, dressings, or the hands of the attendant.

A second case is recorded by Kingsbury.[2]

A physician sustained a slight abrasion of the elbow and a few days later operated on a patient who at the time had a vaginal discharge. A week after the original injury and three days after the possible exposure to gonococci, he complained of pain in the elbow. The original slight abrasion became a shallow ulcer 2.5 by 1 centimetre in diameter surrounded by a reddened area two centimetres in width. Circumscribing this latter, several large bullæ appeared and the axillary glands became large and tender. Smears of this lesion showed Gram-negative intracellular diplococci and cultures showed, in addition to a few staphylococci, a Gram-negative coccus which failed to grow on plain agar, failed to ferment maltose and saccharose, but fermented dextrose. The lesion healed in three weeks with fomentations and protargol applications.

In November, 1927, in examining a routine wound culture from the surgical service Gram-negative diplococci were found. These were intracellular in the direct smear and grew only on enriched media. Further studies showed this organism to be gonococcus.

A second and similar case presented itself in March, 1928. In this case also we were able to demonstrate the gonococcus in the pus from an abdominal wound.

CASE I.—A single girl, twenty-two years of age, entered the Emergency Ward of the Massachusetts General Hospital November 16, 1927, complaining of lower abdominal pain of twelve hours' duration. On rising in the morning the patient had felt nauseated and ate little breakfast. At 10:00 A.M. she had sudden, severe, cramp-like pain in her lower abdomen which doubled her up and was felt about equally in both lower quadrants. The pain steadily became worse and was somewhat intermittent in character, appearing in acute spasms. She vomited four or five times during the afternoon, and the pain gradually became localized in the right lower quadrant.

Her bowels had been regular and the movements normal in character. There had been no frequent or burning micturition. The patient denied vaginal discharge. Her periods were always regular; she had just finished her past period which had lasted four days, was on time, and the flow normal and of the usual character and amount. During the last few periods, however, the patient had noticed cramp-like pains in both lower quadrants. This was unusual for her.

Physical examination revealed a healthy girl, of normal development. There was marked tenderness and moderate spasm in her right lower quadrant in region of McBurney's point and extending well down to the suprapubic region. The introitus admitted one finger with ease. There was very little discharge. The uterus was normal in size, shape, and position and was freely movable. There was marked tenderness in the right vault. The left vault was negative. Rectal examination revealed tenderness on the right side of the pelvis. The temperature was 102° F. by rectum. White blood cells, 32,000. Urine negative. It was thought best to explore the patient because we were not certain of the diagnosis of acute salpingitis as many features of the case favored a diagnosis of acute appendicitis.

Under ether anæsthesia a right paramedian incision was made. Both tubes were injected, tortuous, and œdematous. A small quantity of thick pus was expressed from each and a culture taken. The appendix was normal. It was removed in the routine manner and the wound closed without drainage.

The convalescence was uneventful until the fifth day, when the patient began to run a temperature up to 101° to 102° daily. The wound was obviously infected and a large amount of bloody pus evacuated from the œdematous tissues on the fifth day. Smears of this pus showed Gram-negative intracellular diplococci, and a pure culture of gonococcus was grown from this, as well as from the pus obtained from the tubes at the time of operation.

The abdominal wound was Dakinized and the sepsis cleared up in about three weeks. Ten per cent. argyrol instillations were also used. Cultures taken from the wound three weeks after operation were negative for gonococci. The patient was discharged on the twenty-fifth day. The infection in this case was subcutaneous and superficial to the fascia.

Bacteriologic Studies.—Pus taken from the Fallopian tubes at the time of operation and planted upon ascitic agar and blood agar showed at the end of twenty-four hours' incubation a scattered growth of small grayish colonies containing Gram-negative diplococci. The colonies were at first quite small, but on incubation for a second twenty-four-hour period increased in size, became lightly granular, and showed a somewhat lobate to serrate edge. The organism grew best on ascitic agar, very slowly on blood agar, and not at all on plain agar. It fermented dextrose and failed to ferment maltose or saccharose. It agglutinated in dilutions of from 1/20 to 1/160 with serum from a rabbit previously immunized with several gonococcus strains, and failed to agglutinate with normal rabbit serum in corresponding dilutions.

Six days after operation, a smear from the abdominal wound showed large numbers of intracellular Gram-negative diplococci. Cultivation, sugar fermentation, and subsequent agglutination showed these organisms to be gonococci.

Twenty days after operation gonococci could not be found.

It is interesting to note that in this case we were unable at any time to demonstrate gonococci from the cervix or urethra.

CASE II. A single girl, twenty-three years of age, entered the Emergency Ward of the Massachusetts General Hospital March 4, 1928, complaining of abdominal pain of twelve hours' duration. At 4:00 A.M. on the morning of entry the patient awoke from a sound sleep with generalized lower abdominal pain, steady in character, quite severe, and lasting about fifteen minutes. The pain continued intermittently up to the time of entry with an increasing tendency toward localization in the right lower quadrant. There was no nausea or vomiting. No history of abnormality of bowel movements or urinary frequency or burning was obtained. No leucorrhœa had been noted by the patient. Her periods were regular and normal in every way and not accompanied by pain. The patient had never had a similar attack before.

Physical examination revealed a girl of normal development. Her face was flushed. There was marked tenderness and moderate spasm localized over McBurney's point over an area which could be covered by the tip of one finger. The introitus admitted one finger with ease. No unusual discharge was noted. The uterus was normal in size, shape, and position and was freely movable. The vaults were negative. Rectal examination was also negative. The temperature was 102° F. by rectum. White blood cells, 11,000. The urine (catheter specimen) was loaded with pus. An X-ray of kidney regions was negative for stone.

We were unable to make a differential diagnosis between appendicitis, salpingitis, and pyelitis, so exploration was deemed best. Under ether anæsthesia an incision was made along the outer border of the right rectus muscle. The appendix was normal. Exploration of the pelvis revealed no free fluid, no thickening of the tubes, and no adhesions. The end of the right tube was brought into the wound but nothing abnormal was noted. The appendix was removed in the usual manner and the wound closed without drainage, the post-operative diagnosis being pyelitis.

On the fourth day after operation the patient began to run a daily temperature of from 101° to 102° F. No noteworthy change was noticed in the wound until the eighth day when it became obvious that there was a large subcutaneous collection of fluid. On this day a large amount of bloody serum was evacuated. A pure culture of gonococcus was grown from this material. Cervical smears were then obtained which were also positive for gonococcus by Gram's method of staining. Urine examination on the twelfth day was negative. The wound was treated by the Dakin-Carrel method and instillations of 10 per cent. argyrol. The active sepsis disappeared in about two weeks and the patient was discharged from the hospital on the twenty-eighth day. In this instance the infection was also confined to the subcutaneous tissue.

Bacteriology.—A routine swab taken eight days after operation from the abdominal wound showed large numbers of intracellular Gram-negative diplococci which on culture grew well on ascitic agar, and fresh rabbit blood agar. These organisms fermented dextrose, but not maltose or saccharose and agglutinated with the immune rabbit serum in dilutions up to 1/640. A prozone of inhibition was noted in the first dilutions—a well-marked inhibition in the 1/10 dilution and slight inhibiton at 1/20. Normal rabbit serum agglutinated the organisms in dilutions of 1/10, but not in the higher dilutions.

From both the cervix and the urethra we were able to demonstrate the presence of gonococci both by smear and by culture.

Discussion.—The symptoms of these two cases of acute salpingitis simulated those of acute appendicitis to such an extent that the differential diagnosis between these two conditions seemed hinged upon the findings at operation. In the first case the diagnosis was evident after exploratory laparotomy, but in the second case even after thorough exploration and careful examination of the Fallopian tubes, it was impossible to say that they were abnormal; yet they were evidently the seat of a very acute salpingitis, so early in all probability that the usual gross picture of an older process was

entirely absent. In this latter case, only by bacteriologic studies was the diagnosis made.

As to the source of the wound infection there is no direct proof. It is probable that in both these cases the organisms were introduced into the wound at the time of operation, remained latent for a short time, and by their increasing activity caused the mildly septic temperature and the obvious infection which became noticeable on the fourth and fifth days, respectively. There is, however, the more remote possibility of contamination of the wound by indirect infection from the genitalia.

Although no secondary cases were noted which could be ascribed to either of these contaminated wounds, as a general principle it should be borne in mind that the discharges, the dressings, and the instruments employed in caring for such cases are potential sources of similar infection in the hospital ward. The rapid spread of gonococcus infection from patient to patient even under the most exacting precautions is well known and justly feared, especially by those caring for female children in an open ward.

From the two cases presented and from the two which are reviewed above we may draw the conclusion that the duration of infection is more appreciably shortened by treatment with the silver compounds commonly used in this disease than by any of the more common and less specific antiseptics used as dressings.

SUMMARY

Two cases of acute salpingitis simulating appendicitis are presented. The unusual feature in both cases was a secondary infection of the laparotomy wound with the gonococcus. Fever and visible wound infection were present four and five days post-operatively. In one of these cases the diagnosis of salpingitis was obvious, in the second it was made only by bacteriologic studies. Dakinization of these two wounds and their further treatment with 10 per cent. argyrol rapidly freed the lesions of gonococci.

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LYMPHOSARCOMA OF THE GASTRO-INTESTINAL TRACT

WITH A REPORT OF THIRTEEN CASES*

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Lymphosarcoma of the gastro-intestinal tract cannot be considered as rare in occurrence, still it is so uncommon that isolated case reports are constantly appearing in the literature. There is wide variation in opinion regarding this condition, especially concerning the classification of various forms and its relation to other types of lymphatic tumors. Minot and Isaacs [1] have suggested the use of the terms lymphoblastoma or malignant lymphoma to include all types of malignant lymphatic tumors, and others have adopted the same nomenclature. Under this name they include (1) lymphatic leukæmia, (2) pseudo-or aleukæmic lymphatic leukæmia, (3) Hodgkin's disease, and (4) lymphosarcoma. There are considerable grounds for this classification as Ewing,[2] in considering the etiology, says: "It seems possible that in tuberculosis may eventually be found a connecting link between lymphæmia, pseudoleukæmia, some cases of Hodgkin's disease and some forms of lymphosarcoma." However, due to this variation in terminology, and also to the fact that many cases are reported either with no or only partial microscopic diagnosis, a complete tabulation with resultant conclusions is impossible. Many fibromyosarcomas are erroneously classed with the lymphatic tumors. We have two such cases, a brief résumé of which is given later.

Ewing [2] describes lymphosarcoma as a true malignant neoplasm arising in lymphatic tissue from proliferation of typical lymphocytes, and occurring as either a localized or diffuse process. In the stomach sarcomas constitute about 1 per cent. of all gastric tumors, most of which are either spindle-celled myosarcomas or lymphosarcomas. In the intestines sarcomas are relatively much more common. According to Liu [3] lymphoblastomas are the commonest tumors found in the small intestine, occurring three times as often as carcinomas. They may occur in any part of the intestine, but are most often found in the terminal portion of the ileum. They may be single or multiple. While rare in the appendix, Friend,[4] in 1926, found nineteen cases reported and added one of his own.

Sarcomas of the gastro-intestinal tract may occur at any age, but are found most frequently between the ages of twenty-five and forty-five.

Rankin [5] gives the sex occurrence as equal, but my own studies of the reported cases lead me to agree with Liu [3] that males are afflicted twice as commonly as females.

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Practically nothing is known regarding the etiology of these tumors. The theory of growth from embryonal cell groups has many supporters. Others feel that added to this there must be some exciting cause, such as tubercular infection. Certainly tuberculosis seems closely associated with sarcomas in many cases. Peterson [6] in a compilation of eighty-five cases found three where the tumors occurred six to ten weeks after a severe contusion of the region.

The symptoms presented by sarcoma of the stomach are those presented by any other tumor and vary with the size and location. As a rule gastric dilatation is not so marked as in carcinoma, and the tumor is apt to be larger and therefore more easily palpable.

In sarcoma of the intestines the one practically constant symptom is pain, generally of a colicky nature, occurring as a rule throughout the middle of the abdomen and not affected by eating. There may be slight loss of weight and slight fever. Vomiting is not a prominent symptom as a rule. There may be a history of increasing constipation. While narrowing of the intestinal lumen is a common finding, Libman [7] in 1900 could find no case of complete stenosis reported and I have found none since. Obstruction may be caused by intussusception which occurs not infrequently. Next to pain the most common finding is the presence of a palpable tumor increasing fairly rapidly in size. In some cases this is the only complaint the patient has.

The diagnosis is very difficult. Presence of a palpable tumor taken in conjunction with röntgenological findings of a partial stenosis, and occurring in a young patient, may at times make it possible, but not as a general rule. A good proportion of these patients come to the surgeon with symptoms of an acute abdomen and the correct diagnosis is only made at operation.

The duration of the disease is variable. Here it is that a uniform nomenclature and more accurate microscopic diagnosis in reported cases would help to clarify our ideas. Fisher [8] makes the statement that most patients suffering from intestinal sarcoma die within nine months. This is a shorter period than given by most writers, the average being about eighteen months.

The prognosis is also variable and depends on the type of sarcoma and also the kind and time of treatment. Farr [9] says the outlook in sarcoma of the stomach is no worse than in carcinoma, while Graves [10] speaking of sarcoma of the intestines says: "Death is the usual outcome." Some few cures have been reported. Kapel [11] reported one of fifteen and another of nine years' duration. One of our cases is alive and well eight years after operation.

There is some difference of opinion regarding the proper treatment of this condition. We must remember that no one man or clinic group has had a sufficiently long series of cases upon which to base their opinions—so that both the quoted opinions of others and our own conclusions are subject to change by future experience.

Considering the treatment the cases naturally fall into two groups. First is the very small group where the diagnosis can be made before operation and where the tumor is apparently resectable. Should these cases be submitted to the relatively dangerous operation of resection (Kapel [11] in his

report of resection in sixty cases of sarcoma of the stomach gives an operative mortality of 18 per cent.), or should they be given deep X-ray therapy, which apparently is so efficacious, temporarily at least, in causing similar tumors in other locations to disappear? Crumston [12] in his article on sarcoma of the stomach gives the treatment as excision. Minot and Isaacs [1] in reporting a case of lymphosarcoma of the small intestine which lived seven years without recurrence and then died two years later, say that no case of that type has lived so long except following surgical removal. They favor surgery and radiation, though they go on to say: "Radiation does not influence importantly the duration, it alleviates symptoms, decreases size of lesions and promotes patient's efficiency." Holmes, Dunn and Camp [13] in their article on lymphoblastoma of the stomach say: "The localized type of this disease should respond well to irradiation therapy or to a combination of irradiation and surgery." Rankin,[5] while saying that treatment is unsatisfactory, thinks surgery seems to offer the best chance and adds that radium may give good results. Desjardins and Ford [14] say that radiation may or may not cause definite prolongation of life, but it may keep the disease under complete or partial control for varying periods. Soiland [15] is rather pessimistic regarding X-ray treatment. He says: "It appears that we may successfully destroy the altered lymph nodes in every other part of the anatomy, even including those of the mediastinum, but we find our Nemesis in the abdominal cavity."

In the larger group of cases where diagnosis is only made at operation, there seems to be practically a unanimity of opinion that resection should be performed if possible, later writers favoring post-operative X-ray treatment.

In our experience resection, when possible, is still the method of treatment and we feel rather skeptical regarding the value of radiation. Even though incomplete, resection will often greatly prolong the life of the patient. In one of our cases (Case VII) the operator had to cut through tumor tissue in the mesentery of the intestine and yet this patient was well for nearly three and one-half years and had no X-ray treatment. In Case XIII where radiation alone seems to have caused a cure, the diagnosis was never proven and a later review of the patient would seem to show that the condition was tuberculosis of the peritoneum rather than sarcoma.

Resection should be performed whenever possible and may be followed by radiation if deemed advisable. If, however, radiation causes unfavorable symptoms such as vomiting or gastro-intestinal upsets we consider radiation of such doubtful benefit that we do not hesitate to discontinue it.

The use of arsenic should be mentioned. The present status of this drug is well summed up by Desjardins [14]: "Arsenic was used and when large doses were given over a prolonged period did result in transient improvement. However, results were not altogether satisfactory and these drugs are now seldom employed."

A brief summary of our cases follows: (The first six cases were explored only, no attempt at complete resection being made.)

CASE I.—Male, thirty years of age. Pain in lower right quadrant, one hour after eating, for three months. Vomited frequently. Operation showed numerous masses in the small intestine with involvement of retroperitoneal nodes. Specimen showed lymphosarcoma. Died five months after operation.

CASE II.—Female, seven years of age. Symptoms of acute abdomen, tuberculous peritonitis being the first choice. Operation showed intussusception of small intestine caused by prolapse of a tumor the size of a walnut. Enteroanastomosis without resection of tumor. Twenty-six days later a foot of the intestine with the growth resected. Several similar masses were found throughout the intestine. Pathological report—lymphosarcoma. Died six weeks after second operation.

CASE III.—Male, thirty-two years of age. Pain of seven months' duration, extending from symphysis to umbilicus. Operation revealed a tumor of ileum thirty centimetres from iliocæcal valve, with similar tumors in other portions of the ileum. Enlargement of lymph nodes. Pathological report—lymphosarcoma. Died two and one-half years after operation.

CASE IV.—Male, thirty-seven years of age. Discomfort and cramps across upper abdomen for one month. Swelling of feet and distention of abdomen. Operation showed huge tumor mass in retroperitoneal tissues, with metastatic nodes in meso of small bowel and one large tumor in the ileum, probably metastatic. Pathological report—lymphosarcoma. Died one month after operation.

CASE V.—Male, thirty-three years of age. Pain in epigastrium, right upper quadrant and occasionally right lower quadrant for four months. Vomiting at irregular intervals for six weeks. Slight loss of weight. Operation—diffuse infiltration of the small intestine encroaching on the lumen and extending into the meso at several points. One mass the size of a fist. Unquestionably lymphosarcoma. Pathological report—material lost in process of embedding. Died four months after discharge.

CASE VI.—Male, sixty years of age. Pain in lower abdomen especially on left side for three months. Lost a little weight. Operation showed a large mass involving large intestine and ileum adherent in pelvis; non-resectable. Pathological report—lymphosarcoma. Died fifteenth post-operative day.

CASE VII.—Female, thirty-four years of age. Pain around umbilicus for eight months. Loss of weight and strength. Palpable tumor in left side of abdomen. Operation—mass ten centimetres by eight centimetres involving whole circumference of gut about five centimetres from duodenojejunal junction. One large node in mesentery of gut. Resection with end-to-end anastomosis. Pathological report—lymphosarcoma. Died three years seven months after operation.

CASE VIII.—Male, thirty-five years of age. Epigastric pain for six months. Thirty pounds loss of weight. Increasing constipation. Palpable tumor. Operation—three separate tumors of small intestine contained in the first two feet of jejunum. Resection with end-to-end anastomosis of jejunum and duodenum. Pathological report—lymphosarcoma. Unable to trace patient.

CASE IX.—Male, thirty-five years of age. Symptoms of partial intestinal obstruction for five weeks. X-rays showed obstruction in splenic colon. Operation showed constricting mass at splenic flexure. First stage Mikuliecz and cæcostomy done. Pathological report—lymphosarcoma. Died suddenly day after operation.

CASE X.—Female, eighty-four years of age. Tumor size of orange, constant in size, for five weeks, to right of umbilicus. Increasing constipation. Operation showed intussusception at iliocæcal valve caused by prolapse of tumor of ileum about four centimetres in diameter. First stage Mikuliecz operation done. Pathological report—lymphosarcoma. Died on fourth post-operative day.

CASE XI.—Male, twenty-four years of age. Recurring pain in right lower quadrant for eighteen months. Came to hospital with symptoms of acute appendicitis. Operation—diffuse tumor involving entire circumference of terminal four inches of ileum. Tri-

angular segment of enlarged nodes running beyond duodenum. Resection of terminal ileum and ascending colon together with nodes, with side-to-side anastomosis. Pathological report—lymphosarcoma. Uneventful operative recovery. Given deep X-ray therapy. Well one year post-operatively.

CASE XII.—Male, thirty-four years of age. Pain in epigastrium of six months' duration, coming on one day to one hour after eating. Lost twenty pounds weight. Operation—mass size of palm of hand in posterior surface of stomach with enlarged nodes. Distal one-third of stomach resected. Pathological report—lymphosarcoma. In excellent health nine years later.

CASE XIII.—Male, thirty-seven years of age. Severe pains about umbilicus for one month. Lost a little weight. Palpable mass in right side, deeply adherent. X-ray showed general limitation of lumen of small intestine. No operation as condition was deemed inoperable. Diagnosis thought to be sarcoma, though a note was made that there is a possible tuberculous lesion at the apices, so the diagnosis may be tuberculosis of peritoneum. No pathological report. Tumor mass gradually disappeared under X-ray therapy. Three and one-half years later was in excellent health.

Two cases of myosarcoma have been operated.

CASE I.—Male, twenty-eight years of age. Sudden sharp pain in epigastrium to left mid-line. Thought to be perforated gastric ulcer. Operation showed huge tumor on anterior wall of stomach which perforated at operation. Resection done. Pathological report—myosarcoma. Given X-ray therapy, but died eighteen months later.

CASE II.—Female, twenty-eight years of age. Always constipated. Nausea and cramps in abdomen for two weeks. Operation—intussusception due to prolapse of tumor of cæcum. Intussusception reduced and tumor which did not appear grossly malignant, with surrounding cæcal wall, resected. Pathological report—myosarcoma of local malignancy type. Excellent health ten and one-half years later.

RECAPITULATION

There were thirteen cases of lymphosarcoma, all but two proven by microscopical examination, one not operated and one where the material was lost. Ten were males, three were females. Ages range from seven to eighty-four; average thirty-five. Ten cases involved small intestine, two large intestine, and one stomach.

Twelve cases were followed, one being lost track of. Seven died within one year; one died at the end of two and one-half years; one died after three and one-half years; one not operated, so diagnosis not proven, is well three and one-half years later; one resected, is well one year later; one, stomach resected, is well nine years later.

SUMMARY

1. A uniform nomenclature and more careful microscopical diagnosis are needed to enlarge our knowledge of this condition.

2. Treatment is unsatisfactory. Resection when possible followed by X-ray therapy, seems to offer greatest chances for a cure.

I desire to express my appreciation to Dr. Charles L. Gibson for permission to publish these cases, all of which were operated on in his service at the New York Hospital.

Since this paper was written we have had another case of lymphosarcoma of the ileum which I feel deserves inclusion in that we were able to make a diagnosis from the history before operation.

A man of thirty-five years, who was operated upon five months previously for chronic appendicitis now complained of pain to the right of the umbilicus, coming on about two hours after meals with the sensation of the formation of a mass which could be palpated at times. After a few minutes this pain would disappear and there would be a feeling of the letting up of a constriction and the passage through of liquid could be either felt or heard or both.

From this rather typical history the diagnosis of lymphosarcoma was made. X-rays gave the impressions of adhesions in the region of the cæcum. Operation revealed extensive lymphosarcoma of the ileum with involvement of the lymph nodes of the mesentery. Twenty cubic centimetres of ileum were removed with end-to-end anastomosis.

Pathological report was lymphosarcoma. The patient is still in the hospital, although he has made an uneventful recovery and is to receive X-ray treatment.

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THE POST-OPERATIVE COMPLICATIONS OF CHOLECYSTECTOMY

A STUDY OF 700 CHOLECYSTECTOMIES *

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In this report I shall limit the discussion to the study of the post-operative complications encountered in seven hundred consecutive cholecystectomies in the Henry Ford Hospital. These complications are perhaps fewer and simpler than they would be if we were to include our cases of cholecystostomy and also choledochotomy, when not done in association with cholecystectomy, and those cases where malignancy was present. In a later paper, however, we are contrasting the two groups in the types and frequency of unfavorable sequelæ.

No operations on the gall-bladder, except in acute cases, are done in our clinic without a thorough work-up, including studies of biliary drainage and cholecystography. The latter has proven of great value, though it is not yet infallible. Especial attention is paid in jaundiced cases to bleeding and coagulation times; in all cases in which this is prolonged beyond the normal of three and five minutes, calcium lactate (2 per cent. solution in fifty cubic centimetre amounts) is given intravenously. It is our custom to give this twice a day until the bleeding and coagulation times approach normal. In a series of 145 cases in which cholecystography was done, 111 gave positive findings (non-filling, delayed emptying, or stone shadows), and fifteen gave questionable findings. In this series of 126 "positives", ninety, or 71 per cent., showed stones at operation. Nineteen of the 145 cases gave negative results by cholecystography.

The gall-bladder is not removed unless it shows, on direct inspection and palpation, some sign of disease, such as adhesions, thickened walls, scarring of liver capsule around it, or stones in the gall-bladder or ducts. I am still in doubt, however, as to whether the gall-bladder should be removed where there is no shadow of the dye in the gall-bladder films and yet direct examination shows an apparently normal structure. I have decided against removal of such a gall-bladder, and later thought it should have been excised. On the other hand, we have removed the gall-bladder in nineteen cases where there were normal cholecystograms, but some positive findings of previous disease. As the results have not been entirely satisfactory in these cases, we believe that a normal cholecystogram probably means normal gall-bladder physiology.

To study accurately post-operative complications one should understand

* Read before the Southern Surgical Association, December 12, 1928.

thoroughly the pre-operative condition and the treatment used, and should know also the operative findings and procedures. For this reason I am giving a brief outline of the routine in this series of cases.

To have the patient in as nearly normal physical condition as possible no cathartics are used. The abdomen is shaved before the patient goes to the operating room. A soapsuds enema is given the morning of operation and 1/6 grain of morphine and 1/150 grain of atropine are given a few minutes before the patient leaves the floor. When it can be arranged, the patient enters the hospital twenty-four hours or more before operation to avoid, as far as possible, newly acquired respiratory infections. Ethylene gas, often with an ounce or two of ether, is administered by professional nurse anæsthetists. The operating table is inclined with the foot one to two feet lower than the head.

After cleaning up with tincture of iodine and alcohol an upper right rectus incision is made, beginning a little to the right of the mid-line and extending to two fingers' breadths below the umbilicus. After incision is made through the anterior sheath of the rectus the entire muscle is retracted outward, and incision is continued through the posterior sheath and the peritoneum. Moynihan[1] refers to this incision as having been first used by Hartmann and Kocher, and it has recently been described by Graham.[2] It gives an excellent exposure, prevents injury to the rectus muscle nerve supply, and is less likely to be followed by hernia.

Our procedure is to strip the gall-bladder from the liver, starting at the fundus, though in a small number of cases in this series the cystic vessels and duct were first clamped and divided and the dissection carried on from there outward. The cystic artery is tied separately with No. 1 chromic catgut. The cystic duct stump is cauterized with carbolic acid, washed off with 70 per cent. alcohol, transfixed, and ligated with fine chromic. In this series all cases were drained to the cystic duct stump with a small cigarette drain with smooth rubber surface, the drain being entirely removed on the fifth or sixth day after operation. In only one case have I ever made closure without drainage following cholecystectomy, and that was in 1914, early in my career as Resident Surgeon at the Johns Hopkins Hospital. There was a well-remembered conversation the following day with Dr. William Stewart Halsted, the professor, and I have never had the heart to repeat the procedure, though we did have a 100 per cent. recovery without any complications in that little series of one.

Only occasionally do we suture the peritoneum over the raw bed left where the gall-bladder is stripped from the liver. The omentum is brought up and placed against this area and around the drain as completely as its volume allows. The peritoneum and posterior sheath of the rectus are closed with continuous plain No. 1 catgut. Three or four silkworm-gut sutures are placed down through the anterior sheath, a small portion of muscle, and back through the skin. The anterior sheath is closed with figure-of-eight chromic No. 2, the subcutaneous with plain catgut interrupted. The skin is closed

with interrupted fine silk sutures. Silver foil is placed along the incision, gauze pads are used as dressing, and the wound is strapped securely with adhesive extending well around to the back on each side, care being taken to avoid undue compression of the lower chest and obstruction of thoracic breathing efforts.

When the patient is returned to his room, he is usually conscious or nearly so. If the pain becomes bothersome, pantopon in doses of ½ to ¼ grain is used every four hours the first day. Water is given by mouth early, unless contraindicated by nausea. It is given also by rectum, vein, or by hypodermoclysis. The patient is turned frequently (*i.e.*, every half-hour) from side to side, and within a few hours a partial sitting position is possible by the easy adjustments of the Ford Hospital bed, which has proven so popular with manufacturers and is now seen in most hospitals. It is a Gatch [3] bed, modified by worm-gear elevating and lowering devices.

The drain is entirely out on the fifth or sixth day, and the silk and silkworm sutures are removed on the tenth day. The average patient is ambulatory in two weeks and is discharged as soon as his strength permits, normally on the sixteenth day. We encourage exercises as described by Dr. Eugene Pool [4] and prescribe massage wherever it can be afforded.

Transfusion of blood is used freely and with little more indication than is asked for intravenous infusion of physiological salt solution, and I believe that it has prevented shock and hæmorrhage in many cases, especially those complicated by jaundice. Indirect transfusion is used almost entirely.

Before introducing the material on post-operative complications we will present certain facts in regard to the previous surgical history of the seven hundred cases, the extent of the operative work done on these patients in our clinic, and the reports from our pathological laboratories.

TABLE I

History of Previous Operation

	Cases
Tonsillectomy	110
Appendectomy	91
Biliary tract operations	29
Hysterectomy	28
Salpingo-oöphorectomy	27
Other gynæcological operations	27
Laparotomy	12
Rectal operations	12
Nasal operations	10
Kidney operations	8
Herniotomy	7
Amputations	4
Gastro-enterostomy	3
Removal of bone tumor	1
Removal of coccyx	1

Twenty-nine, or 4.014 per cent., of our 700 cases of cholecystectomy in this series had had previous biliary tract operations elsewhere; 297, or 41

per cent., had had a total of 370 previous operations on other parts of the body. One would surmise from the study of this chart that many of them had an acute or chronic infection which might very well have etiological significance in connection with the cholecystitis. It is also probable that some of the appendectomies were done at a time when the gall-bladder condition was already primary.

TABLE II

Operations Associated with Cholecystectomy

	Cases
Operations on common duct	86
Operations on cystic duct	44
Appendectomy	435
Release of adhesions	60
Operations on tubes and ovaries	41
Perineal repair	28
Hysterectomy	23
Suspension of uterus	18
Gastro-enterostomy	10
Enteroplasty	6
Drainage of gall-bladder abscess	4

In 496, or 70.8 per cent., of the 700 cases we did work beyond a simple cholecystectomy at the time of operation, which represents a total of 755 operations on the 496 cases. Four hundred and thirty-five, or 62 per cent., had appendectomy done at the same time. The frequent association of chronic appendicitis and cholecystitis rather suggests that appendicitis is often the forerunner of cholecystitis. I have seen two cases where there was an acute cholecystitis associated with acute appendicitis, only one of them, however, in this series. I will speak further of the effect of multiple operations on our mortality rate, especially where another incision at the one session was required.

TABLE III

Pathological Diagnosis

Cholelithiasis		386
Cholecystitis, chronic		595
Catarrhal cholecystitis	65	
Strawberry gall-bladder	16	
Calcified gall-bladder	2	
Papillomatous gall-bladder	1	
Normal gall-bladder	2	
Cholecystitis, acute or subacute		105
Acute exacerbation of chronic	25	
Gangrenous gall-bladder	13	
Perforated gangrenous	8	

Table III is made up from the report of our pathologist, Dr. Frank W. Hartman, of examinations carried on at the time of removal of the gall-bladder and studies of microscopical sections of the gall-bladder wall.

TABLE IV

Post-operative Complications Peculiar to Gall-bladder Operations

	546 cases 1916–1926	154 cases 1927–1928	
Post-operative hæmorrhage	4	1	
Secondary closure wound	6	1	
Pneumothorax	1	0	
Hernia in operative scar	1	1	
Persisting biliary fistula	2	2	105 days in hospital
Pancreatitis	4	0	84 days in hospital

Wound completely healed * 30 days post-operative; 14.6 days post-operative

We now arrive at the statistical data which prompted this discussion, namely, the post-operative complications. I am showing two tables—first one, No. 4, giving the complications more or less peculiar to gall-bladder operations. For the sake of comparison we have drawn a line of division in our series at the end of the year 1926, including in the first group those cases recorded from the opening of the Henry Ford Hospital in 1916 to December 31, 1926 † and in the second group the cases recorded after January 1, 1927.

This table shows five post-operative hæmorrhages, of which two were fatal. One came on three weeks after operation from the cystic or, possibly, the hepatic artery in a patient who had had stones in the hepatic ducts as well as in the gall-bladder. The patient died of acute hæmorrhage before an operation could be done. The other patient died on the eighth day, following the breaking open of the wound and hæmorrhage. Myocarditis was a complicating factor in the second case.

The number of cases necessitating secondary closure of the wound—in spite of figure-of-eight chromic catgut, silkworm gut and firm binding—may seem rather high. Our custom has been to bring the drain through the upper end of the primary incision. If the experience reported in the literature could be summarized, we would soon know whether a separate stab incision outside of the rectus or in the flank is the better way. Only one patient died in this group of seven after secondary closure of the wound, a case in which the second closure was made on the eighth post-operative day with through-and-through interrupted silver wire, as is our usual custom.

So small a percentage of post-operative hernia speaks well for the type of incision above described. On the other hand it may prove to be too low an estimate when we have finished the recalling process which is now under way. Our patients are kept in bed twelve to sixteen days, so that wounds have healed solidly before discharge from the hospital.

The number of persisting biliary fistulæ is small, as this paper does not include cancer cases or operations on the strictures of the common duct, unless associated with cholecystectomy. Under "wound completely healed",

* Average includes choledochotomy.

† It should be noted that one year, 1918-1919, our clinic was closed, and the entire surgical staff was with the United States Army in France. The Hospital buildings were turned over to the Government by Mr. Henry Ford.

the average period seems a long one, but this includes the cases of common-duct drainage. In the earlier years it was our practice to insert several drains instead of the present single, small, smooth, cigarette drain. Then, too, by "wound healed", is meant the complete closing over with epithelium.

TABLE V

Post-operative Complications

	1916–1928		1927–1928		Total
	No. of cases	Per cent.	No. of cases	Per cent.	No. of cases
Wound infection	22	4.0	3	2.0	25
Bronchopneumonia	8	1.4	1	.65	9
Lobar pneumonia	3	.6	0		3
Pleurisy with effusion	2	.36	3	2.0	5
Massive collapse of lung	0		1	.65	1
Pulmonary embolus (infarct)	2	.36	4	2.6	6
Myocarditis fibrillation (angina pectoris)	7	1.28	2	1.3	9
Phlebitis	6	1.2	1	.65	7
Pyelitis—cystitis	5	.9	3	2.0	8
Peritonitis (general)	1	.18	1	.65	2
Paralytic ileus	0		1	.65	1
Thrombosis (femoral vein)	2	.36	0		2
Thrombosis (iliac and vena cava)	0		1	.65	1
Total					

In the second table, No. V, by "wound infection" we mean stitch abscess or some sign of pyogenic infection. I am sure we would have a higher percentage if we took routine cultures, especially in cases where there is drainage of bile and we have positive cultures from the gall-bladder. Drainage of bile has not been included on this chart as a post-operative complication, and yet probably should be regarded as such, except where the common duct is drained. Because of the careful ligating of the cystic duct, such drainage is not to be expected, and we are convinced that in at least the majority of cases it comes from an accessory bile duct and less frequently from damaged bile ducts on the raw liver surface.

In the earlier years nitrous oxide gas and ether were used as the anæsthetic, as contrasted with ethylene gas and less ether during the last five years. Immediate post-operative discomfort and possibly respiratory complications have been less as the result. The number of cases with phlebitis seems rather low in this table, especially in the second column which shows three cases of pulmonary embolus; certainly the phlebitis was not where it could be located clinically. The thrombosis and embolism cases continue to be our *bête noire*.

The low rate for peritonitis cannot be said to argue against the much smaller amount of drainage left in the wound in contrast to the much larger amount of fifteen years ago.

From the literature we cannot get accurate knowledge of the amount of paralytic ileus of fifteen and twenty years ago, but it is my impression that it is now much less frequent than formerly. Experience shows that post-

operative distention is not the frequent problem that it used to be, since the use of strong cathartics as a pre-operative measure has been discontinued, and that paralytic ileus is now occurring in a much smaller per cent. of cases.

TABLE VI

Deaths

Cause of Death	1916–1920 Cases	1921–1922 Cases	1923–1924 Cases	1925–1926 Cases	1927–1928 Cases	Total Cases
Primary hæmorrhage	1			1		2
Pulmonary embolus	1		1		3	5
Bronchopneumonia		1	4	1	1+ shock	7
Myocardial failure		1	5	3		9
Acute hæmorrhage pancreatitis	1					1
General peritonitis			1		1	2
Pyloric obstruction	1					1
Acute gastric dilatation				1		1
Gall-stone in common duct				1		1
Multiple liver abscess					1	1
Pyonephrosis—Thrombosis iliac veins and Vena cava					1	1
Total number of deaths	4	1	11	7	7	31
Total number of operations	32	80	257	177	154	700

This table, showing the cause of death, is striking in that shock has not been placed as the cause of death in a single case. Undoubtedly it did play a considerable part in the cases where death occurred after operation. However, the free use of transfusions of blood in prolonged cases, poor risks, and wherever there is jaundice or anæmia, undoubtedly is a tremendous aid in preventing the onset of shock. The careful typing of blood in preparation for transfusion is a part of the pre-operative routine.

As there were only two deaths from primary hæmorrhage, neither of whom had jaundice, and no deaths from secondary hæmorrhage, jaundice with prolonged bleeding time appears to be no longer a bugbear, but to have been successfully combated with calcium lactate and transfusions of blood.

I feel that a gall-bladder operation should never be done as an afterthought secondary to a pelvic or other operation unless the condition is very acute. In our series three cases died where the gall-bladder was found diseased and to contain stones, whereas an operation in the lower abdomen was scheduled as the primary operation. A second incision was made on completion of the primary operation and the gall-bladder removed. In another case in which a pyloric obstruction was found at the time when cholecystectomy was done, a gastro-enterostomy followed the primary operation. This patient died three days after the operation. Whenever possible we now make it a point to wait seven to ten days before doing the second operation, and our results have justified this precaution.

Summary.—Of our seven hundred operations we have here charted 102 with complications, the most frequent and least serious being the wound infections which occurred in 3.5 per cent. of the cases. There were no deaths. Pneumonia in twelve cases, or 1.7 per cent., with nine deaths, makes

pneumonia the most serious of the complications. Myocardial failure ranks second with nine deaths. Pulmonary embolus was recognized in six cases, with five deaths.

CONCLUSIONS

We believe that the incidence of pneumonia as a post-operative complication can be further reduced by sufficient immediate pre-operative dental prophylaxis treatments and by having the patients in the hospital a day or two before operation to preclude the danger of acute respiratory infection from outside contact.

The number of myocardial deaths can be further reduced by closer coöperation with competent clinicians, who now must give assurance that any case with any myocarditis or other heart lesion has been brought by them to the optimum time for the operation as far as that individual heart is concerned.

The percentage of thrombosis and embolism cases is more difficult to reduce as the etiology is not so clear. Post-operative exercises as recommended by Pool, and thyroid medication as recommended by Walters may be of benefit. An anti-coagulant injected at the time of operation may offer the best solution.

Four of our deaths were in patients who had a second incision made for removal of the gall-bladder when the primary operation was a pelvic or lower abdominal one. The practice of performing a second operation under the same anæsthesia increases the mortality rate.

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CARCINOID TUMORS OF THE APPENDIX

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During the past thirty years numerous reports, largely from a pathological and etiological viewpoint, have been made of tumors of the small intestine and particularly of the vermiform appendix, which bear a close resemblance to carcinomata, and which have frequently been considered malignant. From the clinical and histological evidence at present these tumors must be considered benign in character. Originally described as carcinoma, they have been, since 1907, reported usually as carcinoids or argentaffin tumors.

These tumors have commonly been found in young adults, usually before the age of twenty-five, or have been discovered at autopsy in those dying of some unrelated condition.

The recent change in the viewpoint of pathologists regarding the origin of these tumors of the appendix is of considerable interest and importance, and for this reason it seems proper to place on record further cases which may not only be of interest but may bring to mind the importance of differentiating these tumors from malignant conditions. This report is based on a recent case together with a study of seven cases other than my own.

True cylindrical-cell adenocarcinomata may occur in the small intestine and in the appendix but, as compared with frequency in other parts of the gastro-intestinal tract, they are very rare. Carcinoma in the intestinal tract in young adults is characterized by rapid growth and early metastases, and must be given a poor or doubtful prognosis. In carcinoma of the appendix and ileocæcal region, attempts at wide resection of the involved and adjacent tissues have been considered the only safe procedure, usually to be followed by intensive deep X-ray therapy.

It may be quite important from the patient's standpoint that an extensive resection be done if the condition is malignant. It may be of almost equal importance to the patient that no extensive operative procedure be carried out if the growth is benign in character.

In view of our present knowledge carcinoid tumors may be considered, from the therapeutic standpoint, in a similar relation to carcinoma, as giant-cell tumor is related to osteogenic sarcoma. Not many years ago giant-cell tumor was treated by amputation or by extensive resections of the involved tissues. Today it is recognized that such radical procedures are unnecessary, and that removal of the tumor tissue only is necessary.

It is, therefore, of utmost importance that a benign carcinoid be differentiated from malignant tumors of the appendix if the patient is to receive the proper treatment. Because of the extensive adoption of the operating room microscopic examination, either by frozen sections or by unfrozen sections

stained with polychrome methylene-blue solution, it is of extreme importance that a correct microscopic diagnosis be made so that the correct surgical procedures may be carried out. Even today experienced pathologists may easily mistake carcinoid for carcinoma unless the former is kept in mind. The occurrence of a tumor without evidence of metastases in a young individual, in the teens or early twenties, should call for an unusually careful examination by the pathologist.

The following illustrates a rather typical case of carcinoid of the appendix:

A boy, seventeen years of age, was admitted to the United States Marine Hospital, Baltimore, Md., October 28, 1928, complaining of abdominal pain. He stated that two days previously he began having cramp-like pains in the abdomen. These pains continued quite severely for a time over the abdomen and then became localized in the right lower quadrant of the abdomen. Although pain has now almost disappeared he still has some discomfort and tenderness in the right lower quadrant of the abdomen. The patient states that this is only one of several similar attacks which he has been having at intervals during the past five years. The history was otherwise essentially negative. Physical examination revealed no abnormal findings worthy of note except in the abdomen. There was no involuntary rigidity of the abdomen over the region of the abdomen. No definite palpable masses could be found, but tenderness on palpation was complained of in the region of the appendix. The temperature on admission was 97.8° F. The pulse was 85. The leucocyte count was within normal limits. An X-ray examination of the right kidney and ureter was made in an effort to rule out the possibility of pathology in the urinary tract. This examination revealed no abnormality. It was thought that the patient had a subsiding appendicitis. Because of the history of repeated attacks of pain in the right lower quadrant of the abdomen together with the fact that the patient was a seaman who frequently would be out of reach of medical attention for several days at a time, he was advised to have his appendix removed. At operation the appendix was found somewhat tortuous, and its tip was a bulbous enlargement. (Fig. 1.) The peritoneum over this bulbous swelling was as normal in appearance as the remainder of the appendix. No glandular involvement nor other tumor masses could be found. The usual appendectomy was done. Upon sectioning the appendix the end was found to be composed of rather firm tumor mass. The lumen was intact, although smaller than the remainder of the lumen proximal to the tumor. The muscularis and peritoneal covering did not appear to be invaded: Sections showed a typical carcinoid or argentaffin tumor with evidence of associated chronic appendicitis.

FIG. 1.—Carcinoid tumor of the appendix, located at tip of the appendix, producing bulbous enlargement. The peritoneum over the tumor appeared unchanged.

The etiological and pathological aspects of carcinoid tumors have been adequately described by Masson, Forbus and others, so that no detailed discussion seems warranted. Briefly, however, the etiology may be summed up according to our present knowledge as follows: Carcinoid cells result from proliferation of the intranervous argentaffin cells of the neurocrine type. The intranervous argentaffin cells originate from the epithelium of the glands of Lieberkühn. These cells proliferating in the connective tissue assume the characteristic appearance of neurocrine cells. Carcinoids are, therefore, tumors of the chromaffin system. Due to the fact that the granules of certain cells have the ability to reduce ammoniacal solutions of silver, the name argentaffin has been given to this type of tumor. The gross pathology may not be pronounced. The appendix may appear quite normal except for the dilated bulbous end. If the carcinoid is small it may be overlooked entirely, and the changes present may be attributed to the changes of chronic appendicitis if microscopic sections are not made. On splitting open an appendix with a carcinoid at its tip, it is noticed that the lumen is small or may be completely obliterated and replaced by this hard fibrous, compact tissue forming the tumor.

FIG. 2.—Carcinoid tumor of the appendix. Section of carcinoid tumor showing tumor mass in the submucosa, but also involving the mucosa. (Low magnification.)

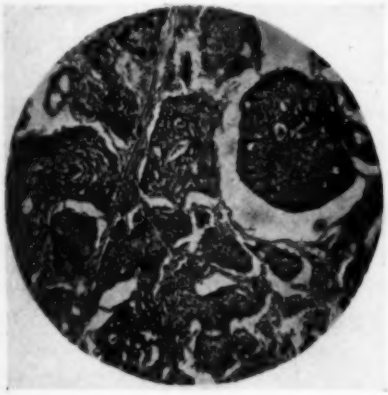

FIG. 3.—Typical arrangement of the cells in carcinoid tumor of the appendix. Epithelial cells arranged in masses in a network of fibrous stroma.

Microscopically (Figs. 2, 3 and 4) the tumor is found to consist of epithelial cells grouped in columns of various size,with a fibrous struma. The predominating cells are oval or round. Some low columnar cells may be seen, and the shape of the cells seems to be largely determined by their location and their relation to the supporting struma. The predominating round cells have their nuclei centrally placed, and the protoplasm may be dotted with acidophile granules. In other cells the cytoplasm contains no granules, but on the other hand may be vacuolated. These cells are found arranged in masses embedded in an eosin staining stroma. This stroma is composed of hyalin connective tissue, a moderate number of blood vessels and a few small lymph spaces, with here and there nerve bundles. The tumor nodule itself may be said to lie in the mucosa and submucosa. The mucosa may be infiltrated with tumor cells, while the muscular layers may show little infiltration. While the invading tumor may involve the muscularis, the peritoneum seems to remain intact.

If any doubt exist as to the true nature of these tumors one may call to his aid the more complicated process of silver impregnation, and may determine the true nature of the cells by the peculiar ability of the granules of the tumor cells to reduce an ammoniacal solution of silver.

In the cases studied, and those reported by others, a constant reliable basis for differential diagnosis may be formed from a study of the arrangement of the cells, the character of the cytoplasm, and the general relationship of the tumor to the intestinal wall.

The microscopic appearance, the small size of the tumor, the absence of metastases, together with its occurrence most frequently in young individuals before the cancer age, should make the diagnosis of carcinoid quite certain, and an assurance may be given the patient and his relatives that further trouble is very improbable.

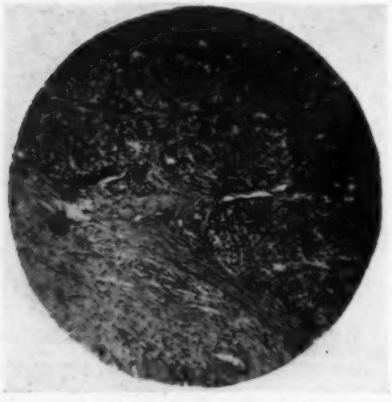

FIG. 4.—Carcinoid tumor of the appendix. Oval and round cells arranged in masses embedded in an eosin staining stroma. In areas the masses of cells appear definitely circumscribed. In other areas the tumor cells may be seen infiltrating adjacent tissues.

It is doubtful if any symptoms may be attributed to the tumor itself unless situated along the body of the appendix, in which case obstruction to the lumen might give rise to an inflammatory reaction. Many of these tumors, previously reported, have been found at autopsy, and so far as the history was obtained there were no symptoms referred to the appendix during life. In those cases occurring in young adults, these appendiceal tumors were usually found at operation, in which case they were frequently associated with an acute or chronically inflamed appendix. In fifty cases found in examining 1200 appendices reported by Masson, forty-six occurred in the tip of the appendix; only four occurring along the body of the appendix. Masson further noted that frequently the lumen was entirely obliterated, so that if any objective symptoms are caused by these tumors they are probably not caused by obstruction to the lumen in the great majority of cases.

SUMMARY

Attention should be called to the fact that the great majority of tumors of the vermiform appendix occurring before the age of twenty-five, will be found upon careful study to be carcinoid tumors rather than carcinoma.

Since experienced pathologists viewing well-stained sections may render a report of carcinoma, it is obvious that sections made in the operation room from frozen sections or from unfrozen sections, stained with polychrome methylene-blue, offer even greater chances for an incorrect pathological report, unless the possibility of this benign tumor is kept constantly in mind.

The correct pathological report is of paramount importance in the treatment of suspicious malignancy.

The differentiation between carcinoid tumors and adenocarcinoma of the appendix, which are superficially very similar, is of the utmost importance. The differential diagnosis may be made by a study of the arrangement of the cells, the character of the cytoplasm, and the relationship of the tumor to the intestinal wall, together with the limited gross pathology, occurring in a patient in the teens or early adult life.

Carcinoids or argentaffin tumors are, according to our present knowledge, benign in character. Therefore, no radical surgical procedures should be attempted, but only the usual appendectomy done.

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Illustrations by Art Department, University of Maryland School of Medicine.

ROUTINE REMOVAL OF THE APPENDIX IN RIGHT INGUINAL HERNIORRHAPHY

REPORT OF NINETY-SIX APPENDECTOMIES IN ONE HUNDRED CONSECUTIVE OPERATIONS FOR HERNIA

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The correlation of diseased or abnormal conditions of the appendix with hernia has been reported by a large number of investigators. The greater number of these have been concerned with the finding of acute appendicular pathology as a complication of hernia. The earliest record of the presence of the appendix in a hernial sac is cited by Deaver [1] as having been reported in the case of Claudious Amyard, Esq., who, in 1735, in the course of an operation upon a boy of eleven, traced a sinus in the thigh to an incarcerated scrotal hernia, wherein was found the appendix perforated by a pin. Morgagni [2] describes finding of the appendix in the hernial sac in the performance of dissection, Ewart.[3] The incidence of association of the appendix with the hernial sac has been variously estimated by more recent analyses.

Wood [4] reported the presence of the appendix in fifty-eight of 3054 hernias of all types, irrespective of the presence of other viscera. Inguinal hernias were found to harbor the appendix more frequently than those of the femoral site.

Robinson,[5] in a series of autopsies, found that in approximately one third of 435 instances the cæcum (and appendix) were in "potential position" to enter the dependent peritoneum of inguinal hernias.

Coley [6] encountered the appendix in the sac of less than 5 per cent. of inguinal hernias subjected to operation; while Kelly [7] expressed the belief that the appendix was a component of 2 per cent. of all hernias, irrespective of variety and location.

Kelly and Hurdon, in 1909, collected two hundred cases in which the appendix appeared in the situations under discussion, the finding of 75 per cent. being identified with inguinal rupture.

Rivet [8] reported 63 per cent. inguinal and 30 per cent. femoral in ninety-four cases of appendicular hernia.

Etiology.—These writers ascribe to Rokitansky, Virchow and Orth the congenital theory of appendical implication: that anomalous development, investiture or inflammation of the fetal peritoneum, is the cause alike of hernial protrusions and appendical participation. Carnett,[9] in an independent investigation, confirmed this theory, which had been ascribed by Jopson [10] to Wrisberg and Lockwood. Hutchison [11] was of the opinion that disease of the appendix might be the exciting cause of hernia—a theory which has attracted little support and no further exemplification. He detailed the occurrence of acute appendicitis following herniotomy; as did Alexander.[12] Unquesably, abdominal rigidity or distention associated with peritonitis of appendical origin may introduce viscera into a hitherto unoccupied hernial sac, and induce incarceration or even strangulation (Davis and Peon [13]). Other writers have been concerned with the existence of acute appendicular infection as a component of hernia (supplementary bibliography).

Purpose of Investigation.—Two considerations prompted the present operative inquiry. They were (*a*) determination of the incidence and extent

of appendical pathology in right inguinal hernia, and (*b*) the practicability of routine removal of the appendix through the usual herniotomy incision. With these objectives, one hundred consecutive right inguinal hernias were operated upon in the Santo Tomas Hospital, Panama, through the courtesy of the chief of surgical staff, Dr. A. S. Boyd; and these included twenty-eight bilateral, eleven irreducible, and three strangulated hernias. Of the one hundred cases, ninety-six were subjected to appendectomy through a hernia incision of ordinary size; and, of these, fifty-one operations were completed by ingress through the sac, and forty-five by a supplementary opening of the peritoneum which will later be described under "Technic". Of the four cases in which appendectomy was not done, one was of strangulation and three of abnormally high cæcum. The completed cases comprised eight in which delivery of the appendix was difficult; and of these, four demanded a degree of technical application which overshadowed the possible benefit to be conferred. In one instance it was necessary to leave *in situ* 1.5 centimetres of the tip of a retrocæcally situated appendix, with sequelæ of pain and fever. There were eight post-operative infections; six of class A, and two of class B. No other local complications were encountered. Stovaine (Billon) was employed intraspinally in nine-three cases; ether was used five times, and novocaine locally twice. Three patients suffered post-operative bronchopneumonia.

Two deaths marred the clinical aspect of the series. One was due to the late effects of secondary hæmorrhage from a needle wound of the left deep epigastric vein, incurred during a simultaneous left inguinal herniorrhaphy at the hands of an assistant; and the second resulted from unsuspected chronic ulcerative colitis.

Pathology.—Doubts concerning the value of this sometimes difficult procedure were definitely dispelled by the pathological findings. No less than eleven instances of sliding hernia of the cæcum, appendix, or both, were encountered. This relatively high percentage can be understood by bearing in mind the large size of hernias in communities in which surgical correction is for many years postponed or habitually avoided. The appendix was found free in the sac contents in six cases; in one case—that of strangulation—acutely inflamed. Grossly diseased appendices (including the adherent) were removed on eleven occasions. Development anomalies totalled twenty-six; and of these, nine presented adhesions or membranes of development type, eight were of abnormally high cæcum or appendix, five were retrocæcal in situation, and four were of redundant cæcum. Two appendices harbored *Endamœbæ histolytica;* and one, an encysted cherry seed. With the inclusion of three cases in which the cæcum was too high to be presented in the operative zone, these abnormalities totalled sixty. From a pathological viewpoint it is seen that the conditions justified performing the appendectomies in addition to the herniorrhaphies, in spite of the additional difficulties involved. The only analogous investigation on record—that of Sheldon [14]—

yielded eight diseased appendices out of twelve removed; a pathological percentage almost identical with that of the present series.

Technic.—The manœuvre employed to gain access to an appendix not readily delivered in the saccular peritoneum was used and described by F. Torek.[15] This consists, in effect, of a supplementary muscle-splitting approach to the peritoneum in the upper angle of the hernia incision. It was Torek's practice, however, to extend upward the skin incision, and to remove the appendix before performing reconstruction in the inguinal canal. Harrigan[16] and Coley[17] made use of this technic. These surgeons have not attempted the routine removal of the appendix in such cases nor estimated the frequency of appendicular involvement. The present writer has found it unnecessary to enlarge the skin aperture, the normal looseness of the tegument in the iliac region permitting adequate retraction. A desire to minimize the risk of infection dictated complete suturing of the conjoined tendon and arching fibres of the internal oblique and transversalis muscles to Poupart's ligament, before performing appendectomy. Simplification of the technic and acceleration of closure have been obtained by the use of a single strand of No. 1 iodin catgut for peritoneum, transversalis fascia, the muscles, and external oblique aponeurosis; locking the suture at the completion of each step.

Although periodic examination of the patients in this series was impracticable, it was well established that most recurrent hernias were accustomed to return to the hospital for the reason that no other medical service was available. There were no recurrences known to the operator one year after completion of the series.

CONCLUSIONS

1. Abnormalities of the appendix, justifying its removal, are present in the majority of individuals with right inguinal hernia.

2. The appendix can be safely removed through the usual herniotomy incision, in a high percentage of cases. Since the addition of this step does not add appreciably to the operative risk, nor jeopardize the effectiveness of hernia repair, routine appendectomy is considered desirable.

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EMULSIFIED CAMPIODOL AS A PYELOGRAPHIC MEDIUM*

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The use of satisfactory shadow-casting media for Röntgen-ray mapping of the cavities and tracts of the body has become of salient importance in the armamentarium of the modern medical man. New substances and new technic for the improvement of this diagnostic method are always to be desired, and it is for this purpose that we wish to record our preliminary experiences with an emulsion of a new iodized oil, campiodol (Frazier and Glaser), applied for the first time as a pyelographic medium.[1]

Barium and bismuth meals introduced by Klose for examination of the alimentary tract were the first chemicals utilized for this diagnostic procedure. The next shadow-casting substance, dry bismuth subcarbonate, was introduced by Chevalier Jackson to outline the bronchi and alveoli of the lung, following which Stewart and Lynah recommended the use of an emulsion of bismuth with olive oil for a similar purpose. The introduction of material opaque to the Röntgen-ray in the urinary tract (urography) is a diagnostic procedure of paramount importance. Up until the last decade its development has met with many difficulties and only by the perseverance of such pioneers as Tuffier, Klose, Voelcker and von Lichtenberg, and their successors, Cameron, Braasch, Kelly, Lowsley, Burns, Graves and Davidoff and others in recent years, has urography been brought to its present high efficiency. The first successful mapping of the urinary tract was accomplished by Voelcker and von Lichtenberg in 1906, using a colloidal silver compound, collargol; however, Tuffier in 1897, Schmidt and Kolischer in 1901, and Fenwick in 1905, had each independently used an opaque ureteral catheter for the outline of the ureters. This stimulated an intensive search for shadowgraphic materials suitable for use in the urinary tract. The method ran the gauntlet of various colloidal silver compounds, which, while satisfactory in shadow-casting, were damaging to the kidney (argyrol, nargol, electrargol, silver iodide, collargol, etc.). Several instances of renal injury due to silver embolism and even some fatalities, due to the toxicity of these substances, were recorded during this period. In an effort to avoid the shortcomings of the various silver compounds, Burkhardt and Polano, in

* Read before the Southern California Medical Association, November 9, 1928.

[1] Original research on campiodol carried out by Charles H. Frazier, M.D., and Mark A. Glaser, M.D., at the University of Pennsylvania. We are indebted to Dr. George W. Raiziss of the Dermatological Research Laboratories for the preparation of emulsified campiodol.

1907, and von Lichtenberg and Dietlen, in 1911, introduced oxygen which, however, proved unsuitable. In 1915 Burns announced the use of the first electrolyte for pyelography, thorium nitrate, claiming for it a relatively low toxicity. Due, however, to toxic effects and in some cases even death, this substance was discarded.

In 1918 the present era of pyelography began with the introduction of the utilization of the halogen salts, sodium iodide and sodium bromide (Cameron and Weld). In advocating the use of sodium iodide, Cameron stated that it was non-toxic, non-irritating to the mucous membranes, non-precipitating in the presence of urine, neutral, and of a viscosity slightly greater than distilled water.

The researches of Lowsley and later those of Graves and Davidoff demonstrated that 12.5 per cent. sodium iodide was superior to all previous substances. This has been borne out by experiences even to the present time. Nevertheless, sodium iodide at times causes irritation of the renal and ureteral mucous membranes, bringing about pain and discomfort, the pain frequently colicky in character.

For some twenty-five years in France and Germany an iodized oil had been used for intramuscular and subcutaneous injection in patients who were in need of iodine therapy. Those administering this product accidently discovered it cast shadows when exposed to the Röntgen-ray. In 1921 Sicard and Forestier began their experimental research upon this substance to determine its value as an opaque medium. Their researches were confined to iodized poppy-seed oil, lipiodol, which they found to be satisfactory in outlining the body cavities.

In recent years iodized oils (lipiodol and iodipin), as well as some of the newer colloidal silver preparations (neosilvol), have been used in pyelography.

In the central nervous system subarachnoid injections of lipiodol were used to determine the presence of spinal block and to outline the ventricles. Here again it had many disadvantages. For the purpose of obtaining a new substance in röntgenographic exploration of the subarachnoid space, Frazier and Glaser reviewed the subject of iodized oils, and with the aid of Dr. George Raiziss synthesized a new compound, iodized rape-seed oil (campiodol). It is an emulsion of this new compound that we wish to introduce as a new pyelographic medium.

EXPERIMENTAL STUDIES

Determination of the Most Suitable Shadow-casting Element.—In the selection of elements for this problem, one must be governed by the ability of elements to cast X-ray shadows upon a photographic plate. In a general way this increases with the atomic weight and the specific gravity. The atomic weight is the more important factor and reaches its limit in shadow-producing power in the neighborhood of silver, with an atomic weight of 107.7, decreasing slightly for elements of higher atomic weight. This is due to the form of the spectral absorption curve, which has a discontinuity

called, "the absorption limit". This limit varies from one element to the next. The factors governing the quantity of the absorbing element in the path of the X-ray must also be considered, such as its proportion in the compound, its specific gravity and the concentration and total thickness of the solutions and suspensions.

With these points in view, thirteen elements were studied, namely barium, bismuth, bromine, silicon, tungsten, strontium, lead, iron, copper, silver, gold, platinum and iodine. In order to eliminate compounds of these elements low in shadow-casting power or low insolubility, the following technic was employed: A saturated solution of compounds of the above-mentioned elements was made up in distilled water and its radiographic opacity compared with a 5 per cent. solution of sodium iodide. If the shadow-casting property were less than sodium iodide, the solution was discarded; if equal, or greater, the solution was tested for toxicity by cisternal injection into the subarachnoid space of dogs. It was found that iodine (atomic weight 126.9) was the element of choice; its compounds cast adequate shadows in low concentrations, and combined readily with many substances; the compounds so obtained were very soluble and of relatively low toxicity. As contrasted with bromine, iodine belongs to that small group of elements possessing the property of selective absorption of the Röntgen-ray. Iodine and its compounds present an opacity far greater than might be expected from its atomic weight. The relative density of the X-ray shadow of an iodine solution increases with the penetration of the rays while that of bromine, for instance, decreases.

Organic and Inorganic Compounds of Iodine.—In an effort to determine the best iodine compound for röntgenographic visualization, the various iodides, iodates, periodates, iodophenolphthaleins, iodized fluoresceins and iodized oleic, benzoic, quinoline and thymol compounds were used. Many of these products proved unsatisfactory because of their insolubility and others failed to cast sufficient shadows. All of these, however, upon cisternal injection proved to be too toxic and for this reason attention was diverted to other substances.

Iodized Oils.—The ability of certain oils to bind iodine depends upon the presence in them of unsaturated fatty acids. In such unsaturated oils iodine is held in firm union. Deterioration of the final product depends upon the method of chemical preparation. If there be an excess of free iodine in the final product, increased toxicity occurs. Dark products resulting from the splitting off of iodine are considerably more toxic than the light transparent ones. In this work oils of low specific gravity, high iodine value and low viscosity were selected. First fish oils were chosen, and cod-liver oil, meeting the above prerequisites, was deemed particularly adaptable because of its rapid absorption by the human body. This was converted into an iodo compound containing 55 per cent. iodine which, however, gradually became dark, cloudy and ultimately turned black; menhaden oil acted similarly; sweet almond oil proved unstable. These oils, however, upon sub-

arachnoid injection proved extremely irritating, but with rape-seed oil a product was finally obtained which proved well suited for all details.

Iodized Rape-seed Oil, Campiodol.—Rape-seed oil, also known as colza oil, is a vegetable oil of brownish-yellow color and is obtained from *Brassica napus, Brassica campestris* and *Brassica rapa,* which all belong to the family of Cruciferæ. Rape-seed oil is composed of the glycerides of stearic, erucic and oleic acids. It is employed as an edible oil and for various industrial purposes. Its specific gravity is about 0.914. The saponification value ranges from 167 to 178, and the iodine value 93.5 to 105.6; its viscosity is 250 at 100° F. Upon iodization a light yellowish product (campiodol) is obtained with a specific gravity of 1.289. The elemental iodine content is approximately 43 per cent. This product deteriorates very slowly upon exposure to light or heat, and upon radiographic exposure an intense shadow is obtained, so much so that dilution products may readily be made without destroying its clinical value.

Toxicology.—Campiodol has a very low toxicity. Dogs have withstood an oral dose of 6.75 cubic centimetres per kilogram of body weight. On injection of 1.5 cubic centimetres per kilogram of body weight into the internal carotid artery with the external carotid ligated no toxic effects were noted. In dogs weighing four to six kilograms four to six cubic centimetres have been injected by cisternal puncture into the subarachnoid space without toxic effects. Spinal fluid-cell counts on dogs in which two cubic centimetres of the iodized oil had been injected into the spinal subarachnoid space varied from 250 to 800 cells per cubic millimetre. At the end of five or six days the cell count ranged between five and fifteen cells per cubic millimetre. In clinical cases of hydrocephalus seven cubic centimetres of the oil were injected into the ventricles with a maximum count of 310 cells per cubic millimetre on the second day. In another clinical case 3.5 cubic centimetres were injected into the ventricles with a maximum count of nineteen cells per cubic millimetre three days after injection. In the spinal subarachnoid space of other clinical cases with an injection of 1 to 1.5 cubic centimetres the cell count varied from eleven to fourteen cells per cubic millimetre. From these figures we may conclude that campiodol has extremely slight irritating qualities; though it produced some cellular reaction, this was of a very low degree.

Emulsions.—Utilization of a straight iodized oil for pyelography would be unsatisfactory for reasons already noted, namely, the high viscosity and non-miscibility. Emulsification reduces both of these undesirable properties. Emulsions may be prepared in various ways, using such emulsifying agents as egg albumin, gelatine, tragacanth and acacia. To reduce the shadow-casting property as little as possible and to make our final product of low viscosity, acacia proved to be the best emulsifying agent. In order to make a stable emulsion it was found that the final product would have to contain one-half of acacia solution and the other half iodized oil. This emulsion

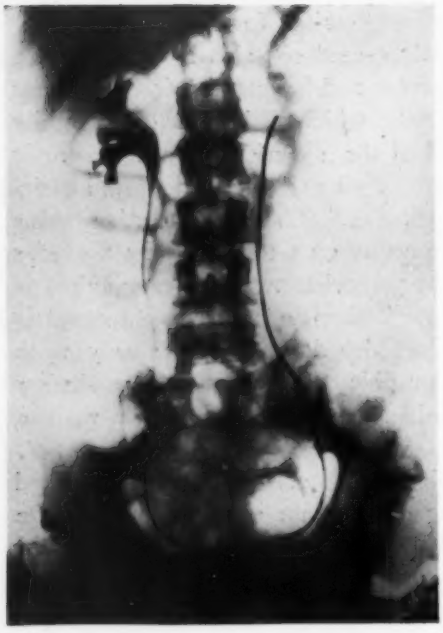

FIG. 1.—Case No. 43-020. Emulsified campiodol, 25 per cent. Normal kidney pelvis.

FIG. 2.—Case No. 10-291. Emulsified campiodol, 25 per cent. Right nephroptosis with two kinks in the upper ureter.

FIG. 3.—Emulsified campiodol, 19 per cent. Early hydronephrosis. Courtesy of Dr. Robert V. Day.

FIG. 4.—Case No. 31-079. Emulsified campiodol, 25 per cent. Ureteropyelogram showing a hydronephrosis and hydro-ureter.

FIG. 5.—Case No. 41-281. Emulsified campiodol, 21 per cent. Turberculous pyonephrosis.

FIG. 6.—Case No. 37-831. Emulsified campiodol, 25 per cent. Ureteropyelogram showing an atrophic hydronephrosis. Note the clear definition of the multiple narrow ureteral strictures.

FIG. 7.—Case No. 27-264. Emulsified campiodol, 19 per cent. Ureteropyelogram showing a reduplication of the kidney pelvis and an incomplete double ureter.

FIG. 8a.—Case No. 30-084. Emulsified campiodol, 25 per cent. Right nephroptosis. Pyelogram is not well defined because patient breathed during exposure.

was prepared in sterile ampules and sealed, and the product further sterilized by exposure to pressure at a temperature of 100° C. Upon bacteriological examination this product proved sterile.

CLINICAL STUDIES

Iodized oils, though casting adequate shadows, gained little favor in urography because of their inability to meet all the prerequisites of good pyelography. These oils were too viscous to readily flow into the renal pelvis unless great pressure could be exerted, the use of special syringes being recommended. Ready drainage would not occur from the kidney pelvis and would occasionally result in obstruction. Air accidentally introduced might produce a trap with subsequent obstruction. Furthermore, these substances being oils were not miscible with the urine in the kidney pelvis and often gave distorted pyelograms. In addition pain was a frequent occurrence due to the resulting obstructions.

Iodized oils have, however, properties desirable for a good pyelographic media. Non-irritation, or lessened irritation, and very low toxicity, due to their inertness as chemical compounds, are of value. The more widely used 12.5 per cent. sodium iodide, while having many advantages as a pyelographic medium, is an electrolyte and therefore in numerous instances irritating to the mucous membranes of the urinary tract. Pyelography has, therefore, become a distressing procedure in some cases due to the irritation of such a pyelographic medium as 12.5 per cent. sodium iodide.

While the primary object of urography is to visualize the urinary tract so as to demonstrate the normal or abnormal conditions, the comfort of the patient during a cystoscopic study should be considered. Wishing to utilize the iodized oils because of their desirable properties, consideration was given to the solving of their shortcomings, namely, non-miscibility and great viscosity. It was found that by emulsifying campiodol with an acacia solution a stable compound was obtained which was miscible with water and of low viscosity. These properties, in addition to such advantages of iodized oils as non-irritability, low toxicity and excellent shadowgraphing, would make an excellent pyelographic medium. We feel that emulsified campiodol is such a medium.

Emulsified campiodol is a stable, grayish-white, oily emulsion, having a specific gravity of 1.097, a viscosity of slightly more than twice that of water, non-irritating, very low toxicity and casting excellent röntgenographic shadows in solutions varying from 7 per cent. to 10 per cent. iodine content. By its use we have eliminated pain, burning, and other signs of discomfort, such as are present in many cases in which 12.5 per cent. sodium iodide has been used. Nevertheless, over-distention of the renal pelvis during injection will produce pain. The non-irritability of emulsified campiodol was especially demonstrated in one case. A pyelogram was made with the emulsified campiodol and the patient did not complain of any discomfort nor irritation. The emulsion was permitted to drain out and a second pyelogram made

with 12.5 per cent. sodium iodide. The patient immediately complained of a burning in the lumbar and bladder regions which continued for several hours.

The emulsion is miscible with water in all dilutions and therefore mixes readily with the urine, permitting good drainage from the pelvis and ureter. (Fig. 8b.) This eliminates the possibility of obstruction and renal pelvic retention as well as distorted pyelograms caused by other viscous iodized oils. There is no precipitation with the urinary salts.

Clinical experience to date has shown that emulsified campiodol gives pyelograms equal to 12.5 per cent. sodium iodide and superior to the other iodized oils. Its shadow-casting properties are excellent in people of all weights. The exact definition of the calices, pelvis, ureter and even to the papillæ in the minor calices is clear cut. The withdrawal of the ureteral catheter into the lower ureter for the injection of ureterograms is rarely accompanied by the usual reflux into the bladder as with sodium iodide, thereby producing a good ureteral outline and eliminating irritating bladder symptoms. (Figs. 4 and 6). This advantage may be explained by the fact that the emulsified campiodol has sufficient viscousness to prevent reflux, not possessed by 12.5 per cent. sodium iodide.

The syringe method was used because the emulsion is, as yet, too viscous for the gravity method. The complaint of any pain or discomfort by the patient in the kidney or ureteral region was the signal for the cessation of injection. In carrying out dilutions of the emulsified campiodol solution, a reduction from 10 per cent. to 7 per cent. elemental iodine content has been made and favorable pyelograms obtained. (Fig. 5.) In this manner the viscousness of the emulsified campiodol was reduced still further. We hope later to adapt this emulsion to the gravity method by making the proper dilutions.

Emulsified campiodol has been successfully used as a pyelographic medium in twenty-five cases, of which six pathological ones are appended. We believe from our clinical experience that it possesses such advantages as good shadow-casting, low toxicity, good miscibility, low viscosity and, especially, non-irritability which justifies its further use, and we hope to report additional experiences.

SUMMARY

1. Emulsified campiodol, used as a pyelographic media, is inert, non-irritating and non-toxic; it is miscible with water and does not precipitate with the salts of the urine and possesses excellent shadowgraphic properties, both as to intensity and to detail.

2. Emulsified campiodol has been used in twenty-five cases with a minimum of irritative symptoms, and therefore possesses a distinct advantage over 12.5 per cent. sodium iodide.

3. Emulsified campiodol gives excellent ureterograms.

4. Emulsified campiodol mixes with the urine in the kidney pelvis; its viscosity is much less than that of other iodized oils and hence is superior to them.

5. Emulsified campiodol is a stable emulsion of iodized rape-seed oil, composed of iodized rape-seed oil, acacia solution and distilled water.

6. Campiodol is an iodized rape-seed oil containing approximately 43 per cent. elemental iodine.

ILLUSTRATIVE CASE HISTORIES

CASE I.—No. 10-291, female, forty-two years of age, housewife, entered the Los Angeles General Hospital, October 17, 1928, with complaint of pain in the back, pain in the bladder, frequency and burning, nocturia three to four times, and weakness. Bladder symptoms for the last ten days. Pain in the back for the last six days. Physical examination revealed some tenderness in the right kidney region and sacroiliac joint. Cystoscopic examination: bladder normal; kidney study showed small amount of pus and occasional Gram-negative bacilli in the right kidney urine; intravenous phthalein appeared from the right kidney in six minutes and left kidney in four minutes; the right kidney returned 15 per cent. of the dye and the left kidney 27.5 per cent. in twenty minutes; no bladder leakage. Right pyelogram (Fig. 2) performed with campiodol emulsion, in the prone and vertical positions, showed the right kidney to be somewhat low and the ureter to have a kink near the pelvis; the pelvis was enlarged, the calices appeared normal. *Diagnosis.*—Right nephroptosis with ureteral kink.

FIG. 8b.—Case No. 30-084. Ten minutes later showing a nearly complete drainage of the kidney pelvis.

CASE II.—No. 30-084, female, sixty years of age, entered the Los Angeles General Hospital, October 26, 1928, with the complaint of sugar in the urine, severe pain in legs and left shoulder, difficulty in urination. The past history showed patient to have been in hospital six months previously with the diagnosis of diabetes mellitus. The average blood sugar was 368 milligrams sugar per 100 cubic centimetres of blood, and patient had sugar in the urine, and a marked pyuria. Cystoscopic examination and kidney study revealed a marked cystitis, with pus in the right kidney urine and none in the left; intravenous phthalein appeared in three minutes from both sides and 10 per cent. of the dye was returned in eighteen minutes from the right side and 9 per cent. from the left side; bladder leakage 15 per cent. Right pyelogram (Fig. 8a) with campiodol emulsion showed the kidney pelvis to be somewhat large, with the kidney dropping about two inches in the vertical position, resulting in a ureteral kink. *Diagnosis.*—Right nephroptosis with early hydronephrosis, and ureteral kink.

CASE III.—No. 31-079, female, fourteen years of age, entered the Los Angeles General Hospital, September 12, 1928, with complaint of pain in both lumbar regions, fever, frequency of urination and headache. The past history is irrelevant, except that patient has had headaches for years, presumably referable to her eyes. The present

illness began three weeks ago. The patient's symptoms becoming progressively worse; has lost some weight, but does not know how much. There are no particularly abnormal physical findings. Repeated urine analyses showed much pus. While in the hospital patient suffered a recurrence of acute symptoms with a temperature of 104° F., and marked pain in the left renal region. Cystoscopic examination revealed a marked cystitis. The left kidney contained much pus and streptococci in short chains; the right kidney was uninfected. Intravenous phthalein appeared in five minutes from the right kidney with an output of 25 per cent. in twenty minutes, while only a trace of the dye appeared on the left side. Left pyelogram (Fig. 4) made with emulsified campiodol showed an hydronephrosis and hydro-ureter. Diagnosis confirmed by operation.

Case IV.—No. 41-281, female, nineteen years of age, entered the Los Angeles General Hospital, December 5, 1928, with complaint of frequency and burning on urination, pain in lower abdomen and leucorrhœa. Past history irrelevant. Present illness began about three months ago, since which time patient has become progressively worse until at present there is a diuria of twelve to fifteen times, and a nocturia of every half hour. Physical examination showed a poorly-nourished Mexican woman. Temperature and pulse slightly elevated. Tenderness in both lower abdominal quadrants. Vaginally a lacerated cervix with marked endocervicitis and tenderness in both fornices. Urine contained much blood and pus, but no organisms. Cystoscopic examination revealed an ulcerative cystitis, most marked about the trigone. Ulcerations suspicious of tuberculosis. Left ureter obstructed at ten centimetres, but passed by means of stylet. Right kidney uninfected; left kidney contained a great number of pus cells, but no organisms found in the Gram and acid fast stains. Intravenous phthalein appeared on the right side in five minutes with a 25 per cent. output in twenty minutes; appearance time on left side fifteen minutes with a 3 per cent. output. Left pyelogram (Fig. 5) with emulsified campiodol showed a marked destruction of the kidney pelvis suggestive of a pyonephrosis. *Diagnosis.*—Tuberculous pyonephrosis of left kidney. Operation confirmed diagnosis.

Case V.—No. 37-831, female, fifty-three years of age, entered Los Angeles General Hospital, November 14, 1928, with the complaint of frequency and urgency of urination, burning, nocturia five to six times, and pain in the right kidney region. Past history showed patient had an uterine operation seven years ago. Present history began about four weeks ago when patient had a severe attack of pain on right side lasting four days. Had a similar attack four months ago on the left side. Physical examination revealed some tenderness in the right lower quadrant and along the ascending colon. Cystoscopic examination showed a bladder mucosa normal, bladder neck smooth; right ureteral orifice normal in appearance and function; left ureteral orifice functionless; right ureter catheterized to kidney, but left ureter catheterized for fourteen centimetres; kidney study showed right kidney to be uninfected and left kidney to be functionless; intravenous phthalein appeared in five minutes on the right side and returned 50 per cent. in twenty minutes; no dye was obtained from the left kidney; bladder leakage showed a trace of the dye. Left ureteropyelogram (Fig. 6) made with campiodol emulsion. *Diagnosis.*—Atrophic hydronephrosis.

Case VI.—No. 27-264, female, fifty-one years of age, entered the Los Angeles General Hospital with frequency of urination, dysuria, backache, chills and fever. Former entry with same complaints seventeen months ago, at which time patient was found to have a left incomplete double kidney and hydro-ureter. With exacerbation of symptoms patient was advised to reënter hospital. Physical examination essentially negative. Cystoscopic examination under spinal anæsthesia revealed a marked cystitis and a small grayish ulcer behind the interureteric ridge on the right side. The left ureteral orifice is gaping and the right is normal in appearance. Both ureters catheterized. Kidney study showed the left kidney to be infected (*B. coli*) and the right kidney negative. Intravenous phthalein showed an appearance time of three and one-half

minutes on the right side and six minutes on the left side. The right side returned 6 per cent. of the dye and the left side 1 per cent. in twenty minutes; bladder leakage 12.5 per cent. Left ureteropyelogram with campiodol emulsion showed a duplication of the kidney pelvis. (Fig. 7.) Diagnosis confirmed at operation.

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MARCH 13, 1929

The President, Dr. Frank S. Mathews, in the Chair

GOITRE PROBLEMS

Dr. Morris K. Smith presented patients from the Thyroid Clinic of St. Luke's Hospital to illustrate certain problems in the treatment of goitre.

Case I.—A man of about thirty-five years, came to the clinic in October, 1927. He presented a moderately severe case of Graves's disease with well-marked exophthalmos, tachycardia and tremor. His weight was 112 pounds; basal metabolism +40. Treatment consisted of hospitalization for six weeks and X-ray continued over a period of fourteen months. He began to improve at once. At present, one and one-half years after beginning treatment, he seems pretty well, weight is 130, a gain of eighteen pounds, and basal metabolism is +24. He is working. He is shown to demonstrate therapy by X-ray, of which little is said at present. It is a method which has given some excellent results in the clinic although requiring a long period of treatment.

Case II.—An unmarried woman entered the hospital eight months ago complaining principally of rapid heart action. Her history extended back three years, although exophthalmos had been present only in the previous two months. Her weight was 145 pounds; basal metabolism +40. Subtotal thyroidectomy was done by the speaker. Four weeks after operation basal metabolism was +7.

Two and one-half months after operation she attempted to resume part time work, but soon noticed palpitation. Basal metabolism was found to be +34. She received six X-ray treatments. At present, six months after operation, she has gained fourteen pounds and her basal metabolism is +9. She is not working and feels pretty well on a regimen of rest.

This patient is shown to demonstrate disappointment as to promptness of recovery, as well as to emphasize the necessity for careful follow-up supervision of these patients. It seems probable that a sufficiently radical operation was not done in the first instance.

Case III.—A woman who was operated on by the speaker ten months ago. She had been sick for two months with moderate exophthalmos and weight loss of eighteen pounds. Basal metabolism was +46. Following operation she was very hoarse and laryngoscopic examination revealed partial paralysis of the left recurrent laryngeal nerve. Two months later her voice seemed to be normal although there has not been an opportunity for another laryngeal examination. Three months after operation she had gained twelve pounds and basal metabolism was zero.

This patient is presented as an apparent recovery after partial nerve

injury and as a satisfactory result thus far as to general condition, in an early case of Graves's disease.

CASE IV.—A colored woman who was first seen two years ago. There was a slight exophthalmos and tremor, well-marked goitre. Weight was 135 pounds, basal metabolism +43. She has had X-ray therapy. During a period of sixteen months nine basal metabolism tests were made, the lowest +25, the highest +54 and the last, six months ago, +49. Gain in weight has been slight. She has seldom admitted nervousness. She has refused operation. She is presented as a case in which metabolic changes are well marked while nervous manifestations are slight.

CASE V.—A young woman who came to the clinic a year and a half ago. Nervousness was the chief symptom. She had lost sixteen pounds in eight months. There was no visible goitre, tremor very marked, pulse rapid, basal metabolism +22. She has been followed in the thyroid and neurological clinics, including a period of hospitalization. She received X-ray over a period of three months. The highest basal metabolism was +38, lowest and most recent +5. Her general condition remains much the same. She is able to work.

There has been much discussion as to whether this patient had Graves's disease. She is presented as an individual with marked nervous and borderline metabolic manifestations.

CASE VI.—A man of thirty-two years has been followed fifteen months. His chief symptoms were weakness, loss of weight, palpitation and nervousness. He had slight exophthalmos, evident thyroid enlargement, marked tremor and tachycardia. He weighed 94 pounds. Basal metabolism was +18. He was hospitalized for six weeks. The outstanding features in this case are prompt gain in weight from 94 to 120 pounds and persistent low basal metabolism, never over +18, and down to +7 at last report six months ago. He has had no X-ray. Advisability of operative therapy has been often discussed.

This patient is also presented as a case in which nervous manifestations predominate. The only feature lacking to substantiate a diagnosis of Graves's disease in him was a more definite elevation in metabolism.

DR. GEORGE M. GOODWIN (by invitation) said that the last two cases belonged in that group in which the question as to the advisability of surgical therapy was a difficult one. Both cases showed the nervous factors much more than the metabolic. In the nervous symptoms they resembled closely cases of thyroid toxæmia, yet their basal metabolic rate had been normal, or almost normal, throughout. These did not seem to him to be true thyroid cases.

DR. ALEXIS V. MOSCHCOWITZ felt from a very casual examination of Doctor Smith's cases of Graves's disease, that with the exception of Case III, all are still rather well-marked cases of Graves's disease, and he is also under the impression that all of them would be benefited by a subtotal thyroidectomy.

Doctor Smith has laid a great deal of stress upon the lowering of the basal metabolism. While this is a very important item, a lowered basal metabolism does not denote a cure of a patient suffering from Graves's disease. As a matter of fact, it has been Doctor Moschcowitz's experience

that patients who had been operated upon for Graves's disease, even if they had a normal or subnormal basal metabolic rate, may still have very distressing residual symptoms.

Doctor Moschcowitz also wished to again emphasize how much harm the indiscriminate use of iodine may do. He has, within the past few years, seen all sorts of diseases of the neck accompanied by swelling, treated by iodine, even if not connected with the thyroid gland. It should be reiterated again and again that the use of Lugol's solution is indicated only as a pre-operative measure in cases of Graves's disease.

Dr. Richard Lewisohn said that over twenty years ago he had treated a number of cases of exophthalmic goitre with X-ray therapy at Czerny's clinic in Heidelberg. Some of these cases showed improvement when reëxamined six months to a year afterward. His objection to X-ray and radium therapy for exophthalmic goitre is that it makes subsequent operation very much more difficult on account of extensive lesions due to the radiation.

Dr. Smith, in closing, said that when a patient with Graves's disease has had the basal metabolism brought back to normal and gains weight she is not necessarily free of the symptoms of the disease. He thinks it is the exceptional case who is well in every respect.

He does not feel that Case I can be considered wholly cured of Graves's disease, but presented him as a man, originally quite ill, treated by rest and X-ray, who is now pretty well and able to work. It is well to remember that radiotherapy is a method of treatment which can be used when operation is refused or contraindicated.

OSTEOSARCOMA

Dr. William B. Coley presented the following patients:

Case I.—*Sarcoma (endothelioma type) of tibia. Extensive multiple metastases to bone and soft parts following amputation. Complete disappearance under systemic injections of the mixed toxins of erysipelas and bacillus prodigiosus, alone. Patient well three years later.* (This case was reported by Doctors Christian and Palmer in the *Military Surgeon,* July, 1927, and in more detail and with full illustrations in the *American Journal of Surgery,* February, 1928.

Captain G. B., male, thirty-one years of age, had his left leg amputated at the middle third of the thigh on September 21, 1925, for a tumor of the shaft of the tibia, which, on microscopical examination by Dr. Ewing Taylor, was pronounced a very cellular myelosarcoma; small polyhedral cells. With this diagnosis, Dr. James Ewing and Dr. E. A. Codman concurred. While the patient complained of pain in the stump, a röntgenogram taken November 24 failed to reveal any evidence of a recurrence. On February 23, 1926, four months after the amputation Röntgen-ray examination showed very extensive recurrence in the stump with marked destruction of bone. January 25, or one month before the recurrence in the stump was noted, a tumor mass the size of a man's fist appeared over one aspect of this stump, and

one the size of a lemon over another aspect. There were metastatic tumors (two inches in size) in the inguinal region, and another one above the umbilicus.

Treatment with the mixed toxins was begun at once, in early January, 1926; the intial dose of .25 minim was gradually increased to 6.5 minims.

The dosage in this case is of extreme importance. Up to January 25, the the highest dose, 6.5 minims, was followed by little reaction, except after the first few doses. Yet the mass in the groin had disappeared and the mass in the umbilicus was much smaller. The dose was increased by one minim a day from February 2 to February 20, when it had reached 18 minims. The treatment was then discontinued on account of the weakness of the patient. A new and extensive growth had appeared in the femur-stump and there was much œdema of the good leg. May 5, several small metastatic nodules appeared under the skin of the abdomen. During May and June the patient grew worse steadily, with metastatic growths appearing in many parts of the body, among which were a considerable involvement of the right clavicle and multiple tumors of the scalp, cranial bones and cervical verebræ. The maximum growth that the tumor of the stump had attained was thirty-one inches The end of the tumor of the stump had broken down with foul discharge.

The toxins were resumed on August 2, 1926, the initial dose of 2 minims being increased daily by 1 minim up to 17 minims. By this time marked improvement was evident, as shown by a marked decrease in the size of all the tumors; the stump had nearly healed.

An interval of rest from September 4 to September 19 was followed by a third series of injections, which were given daily for three weeks. On November 22 the patient's general condition was excellent; he had gained thirty pounds in weight. The stump-circumference was seventeen inches (formerly thirty-one inches); the discharging wound had healed; the multiple tumors of the abdomen, groin, scalp, clavicle and skin had all disappeared. The patient was discharged from the hospital with no evidence of disease on December 5, 1926. As a precaution, a fourth series of treatment was given from February 13 to March 17, 1927, every third day, the initial dose of 3 minims being carried up to 30 minims.

The case was republished in the February, 1928, issue of the *American Journal of Surgery*. In January, 1929, he was in the best of health with no evidence of a recurrence. He is still well at the present time, March, 1929, two years after cessation of the treatment.

Doctor Coley remarked as to end results in general that up to the present time there had been observed at the Memorial Hospital and the Hospital for Ruptured and Crippled, forty-six cases of endothelioma or endothelial myeloma. Of this group, eighteen are alive and well from three to twenty years. The treatment employed in these eighteen cases was as follows: Toxins alone in five cases, toxins and amputation in seven cases, and toxins and radiation in six cases. There were no apparent recoveries in the group of eleven cases treated by radiation alone. Excluding the eleven cases treated by radiation alone, there remain thirty-five cases treated by toxins alone or toxins and radium, with eighteen well from three to twenty years, or 50 per cent.

The endothelioma or Ewing type of sarcoma was described by Howard and Crile in a paper which was published in the ANNALS OF SURGERY, September, 1905. This contained a report of nineteen cases that had been found in the literature in addition to four cases that had come under their personal observation. One of these cases was cured by surgery. Little was known or written about this type of tumor until 1921 when Ewing reported a case with a detailed clinical and microscopic description of the condition.

While there is still doubt as to the exact origin of this tumor, whether it arises from the perivascular endothelium or from endothelial cells of bone-marrow, as Ewing believes, or from the reticulo-endothelial system, it is universally admitted that it forms a separate class by itself. Furthermore, unlike the ordinary osteogenic sarcoma it is exceedingly sensitive to both radiation and toxins.

In regard to the frequency, the endothelioma type was found to comprise about 20 per cent. of the entire group of malignant bone sarcoma (exclusive of giant-cell sarcoma) personally observed, that is, forty-six cases of endothelioma were found in the entire group of two hundred cases of sarcoma of the long bones.

If anything, this type is more malignant than the ordinary osteogenic sarcoma, and is exceedingly prone to early metastases. Few cases are saved by amputation alone. From the result obtained in the case just presented, he thought that there is little reason to doubt that the limb could have been saved had prompt conservative treatment been instituted. In November, 1928, he showed before the New York Physicians' Association another case of endothelioma of the tibia with extensive metastases to the glands of the groin at the time of amputation and further metastases to the iliac fossa and lungs after amputation. In May, 1920, the patient was put upon the mixed toxins, which were kept up for four months; and in addition he received one application of the radium pack to the iliac fossa. He made a complete recovery and was in excellent health at the time of presentation.

It is evident that a disease so prone to early generalization requires some systemic method of treatment. As far as he knew, the toxins of erysipelas and bacillus prodigiosus is the only systemic method that has met with any success in the treatment of these tumors. With radiation alone it is often possible to cause prompt and apparently complete disappearance of the primary tumor; but almost invariably, after a longer or shorter period of time, metastases or multiple tumors appear elsewhere and the disease proves fatal in the end. Putti, in his recent John B. Murphy Oration in *Surgery (Surgery, Gynecology and Obstetrics*, March 1929) on "Malignant Bone Tumors," states: "I have noted the extreme sensitiveness of soft sarcomata, more especially the endotheliomata, for which a few doses suffice to clear away all external evidence of the tumor. But this disappearance is only temporary. Indeed, I have gained the impression that, in some cases, radiation hastened the formation of metastases."

Personally the speaker believes that the ideal treatment of these tumors is a combination of the local effect of radiation with the systemic effect of the mixed toxins, being careful to avoid giving too heavy doses of radium, which, in his experience, which coincides with Putti's, sometimes hastens the development of metastases.

CASE II.—*Inoperable sarcoma (endothelioma type) of humerus. Complete disappearance under toxins and radium. Patient well four and one-half years later.*

E. M., male, forty-seven years of age, was referred to Doctor Coley by Dr. William C. Sheehan and Dr. John B. Deaver, of Philadelphia, July 24, 1924, with a history of having tripped over a low fence, about a year and a half previously, and fractured the left humerus at the upper third. One year later a tumor developed at the site of the injury. Physical examination showed the left shoulder markedly swollen on the outer and anterior aspect, the swelling occupying the whole region of the deltoid, and extending up to the tip of the clavicle and involving the upper third of humerus; it was soft in consistence, semifluctuating, and extended out to the pectoral muscle. The measurement over the axilla and tip of the clavicle was twenty-one inches, five inches higher than the other arch, while the circumference at the highest point of the axilla was fifteen inches. Motion at the shoulder was considerably limited; the left hand could be raised as high as the patient's chin but not to the top of his head; abduction was about forty-five degrees. The skin was normal in appearance and the veins were not dilated.

The röntgenologic and clinical evidence was so clear that it was possible to make a definite diagnosis without a biopsy. Most of the surgeons who saw the patient believed his condition to be inoperable; therefore it was decided wise to try conservative treatment. Injections of the mixed toxins of erysipelas and bacillus prodigiosus were started at once, supplemented by a massive dose of radium (10,000 mc. hours) at seven centimetres distance over three different areas. In four weeks the tumor had diminished five inches in circumference and the patient had regained his lost weight. He proved extremely susceptible to the toxins, a very small dose producing a rise of temperature to 104.5°. In December, 1924, there was evidence of some slight increase in the swelling of the arm, and another radium pack was applied, the toxins being continued once a week until April, 1926.

Physical examination in April, 1926, failed to show any evidence of enlargement of the arm; the patient's general condition was entirely normal, and he was performing his regular work. He had been able to resume work within two months of the beginning of treatment. A röntgenogram taken on November 23, 1926, showed no evidence of disease; function normal. Another röntgenogram taken today also fails to show any evidence of disease. The patient is in excellent health, four and one-half years after the beginning of treatment.

This case has been reviewed by the Bone Sarcoma Registry committee (see Case No. 596) and diagnosed as an endothelioma or Ewing's sarcoma.

It is interesting to note the method of administering the toxin treatment in this case. While for many years Doctor Coley had relied almost exclusively on intramuscular injections, in the present case, by accident his house sur-

geon gave the second or third dose (.25 minim) directly into the tumor; this was followed by a very severe reaction, temperature of 105°. The effect on the tumor during the next two or three days was quite noticeable so that he continued to give local injections almost exclusively during the next month or so. This is the method which he employed in his earleir cases.

During the last two years he had used intravenous injections in a considerable number of cases, getting severe reactions from initial dose as small as 1/48 minim. The great advantage of this method is the certainty of producing the desired reaction without the local reactions which in some cases are rather disagreeable. As far as can be ascertained the results following the intravenous injections are a little better than those following systemic injections, and as yet no fatalities have occurred. The dose is gradually increased as the susceptibility is diminished, 1/48, 1/40, 1/36, 1/30, etc., of a minim. In one patient the dose was gradually increased so that at the end of eight months the patient was getting thirty minims. This patient was not at all sensitive to the toxins and required a dose of twelve minims intramuscularly before any reaction was obtained. The toxins should never be given intravenously until the susceptibility has been tried out by intramuscular injections.

Dr. Howard Lilienthal believed Coley's fluid ought to be used a great deal oftener than it has been, and is being, used. He has had a number of patients, at least twelve, some of whom have been absolutely hopeless and inoperable sarcoma of various types, who have entirely recovered and have remained well after treatment by Coley's method only. He regretted that Doctor Coley is using radiation with his fluid as he feels there is no advantage in it. Massive X-ray radiation is apt to produce blood changes and make it difficult for the patient to resist the reactions which follow the administration of Coley's fluid.

Doctor Coley reported that he agreed with the opinion expressed by Doctor Lilienthal, that the toxins alone without radiation were able to effect a cure in this endothelioma group. He believed that the first case presented this evening, in which very extensive multiple metastases to the bone and soft parts had disappeared under toxins alone and the patient had remained well for three years, would seem to furnish satisfactory evidence to this effect. Furthermore, he agreed with Putti that there was danger of very heavy radiation of a highly vascular endothelial tumor resulting in early generalization of the disease by a too rapid breaking-down of the tumor permitting some of the living cells to escape into the circulation. Doctor Coley had observed several cases in which it seemed difficult to explain in any other way the rapid generalization that had occurred. If a combination of toxins and radiation were to be employed, he advised administering the toxins first, for a week or more, and getting the patient somewhat under their influence, thus lessening the chances of metastases developing. Doctor Coley said it was interest-

ing to note that in the series of fifty-four cases of endothelioma collected by Connor (fifty-two from the Bone Sarcoma Registry) four of the nine five-year recoveries were his (Doctor Coley's) cases, and in all of the four cases the toxins had been used. He stated that there was one case of endothelioma at the Memorial Hospital that had recovered under radiation alone, but in this case no microscopic examination had been made and there had always been some doubt of the correctness of the diagnosis of endothelioma. In the series treated by Doctor Coley, the limb had been saved in seven cases. He called attention to the fact that certain bones had a predilection for this disease. In his series, the femur was involved in twenty cases, the tibia in seven, and the humerus in five cases.

GAUCHER'S DISEASE

Dr. Harold E. Santee presented two cases of Gaucher's disease's who were presented before this Society May 11, 1927. (See Annals of Surgery, November, 1927.) To briefly resume the cases, it may be stated that C. S., now thirty-one years of age, suffered a "sprain in the left hip" in March, 1925. He came under observation in October, 1926, at which time the important findings were anæmia, an enlarged liver and spleen and a painful left hip of which an X-ray showed slight irregularity and loss of detail in the lower half of the margin of the head of the left femur. In March, 1927, these changes had progressed to distinct rarefaction about the head of the left femur and about the pubic and ischial rami. The patient was admitted to Bellevue where a diagnosis of Gaucher's disease was made on the evidence of pingueculæ in the eyes, large spleen, large liver and bone changes. The spleen was extremely large, reaching into the pelvis. After preliminary transfusion splenectomy was done on April 5, 1927. A small section of liver and a lymph node at the hilus of the spleen were also removed. They showed changes characteristic of Gaucher's disease. The convalescence was stormy. Directly following operation a transfusion was given. A post-operative pneumonia developed and it is interesting to note that at the height of his pneumonic infection his white blood cells were only 4800, polymorphonuclears 58 per cent., hæmoglobin 55 per cent. Definite jaundice appeared, with high icteric index (72). Infection occurred in the wound. Altogether convalescence was very slow. The spleen was a nodular type of spleen, more nodular than the only other one reported in Gaucher's disease, which was examined by Ludwig Pick in 1926. He received three more tranfusions while in the hospital. He left the hospital in May. In September he had gained twenty pounds and looked remarkably well. He was maintaining his hæmoglobin at 70 per cent., red blood cells were 3,500.000, white blood cells, 8400, polymorphonuclears 36 per cent., transitionals 7 per cent., lymphocytes 47 per cent., large mononuclears 7 per cent. He was relieved of indigestion and sense of weight in the abdomen, of which he had complained in the spring. His liver remained the same size. His hip showed no improvement.

At present, approximately two years after the splenectomy his hæmoglobin is 75 per cent., red blood cells 3,800,000, white blood cells 12,000, polymorphonuclears 33 per cent., lymphocytes 32.5 per cent., large mononuclears 30 per cent. He is maintaining his general health, apparently, in an excellent manner. He feels well and suffers practically no indigestion. Recent

skiagraphs of the hip show marked rarefaction or absorption throughout the head and neck of the left femur from acetabulum to intertrochanteric line. There is a faint line suspicious of pathological fracture at junction of head with neck. Areas of bone rarefaction are present in the pubic rami and in the left ischium. Resection and fusion of this hip were advised for this patient long since but have not been accepted by him.

The brother of this patient is the second case presented. He was also shown before this Society two years ago. His history apparently dates back to 1917, when a diagnosis of malaria (spleen?) was made. Epistaxis and bleeding from the mouth brought him under observation at that time. In the hospital, later, an enlarged liver was found and periodically since that time he has been under observation for this enlarged liver. During the past five years this patient has noticed anæmia, with shortness of breath and asthenia, some indigestion and a constant feeling of discomfort in the right upper abdomen and across the abdomen, particularly on leaning over. He, too, shows the pingueculæ described by Brill; a liver enlarged to the level of the umbilicus; and a spleen which is enlarged to a similar level. In the past two years he has changed his job because of the symptoms associated with his anæmia, which were dyspnœa on exertion, asthenia and also the weight and discomfort in the abdomen. Clinically, in comparison with his brother, he shows greater anæmia and greater asthenia. The spleen is apparently about two fingers' breadth larger than two years ago. The liver is apparently the same size.

In commenting on these two cases two years ago it was stated that in this disease of the recticulo-endothelial system the manifestations vary quite markedly, as illustrated in these two cases, one marked by chronicity (twelve years), anæmia and symptoms referable mostly to the liver, the other marked by less chronicity (now five and a half years), obvious bone changes and pain and discomfort referable mainly to the spleen. The statement was made at that time that reasoning by analogy, can splenectomy be justified in the second case on the grounds of relief to the damaged liver, as in splenectomy in cirrhosis; as possible relief in a marked secondary anæmia; or as a mechanical removal of a heavy, painful, pressure-producing organ? Certainly no one expects to cure a diffuse disease of the character of Gaucher's by the removal of a single involved element. Relief of major symptoms, however, seems indicated even if it involves a major operation. With the possibility of indirect beneficial results, such as relief to a damaged liver and some benefit to the anæmia, splenectomy seems to be justified. The course of the second case seems to have justified the procedure. A burdensome, pressure-producing organ has been removed. The patient maintains his hæmoglobin at about 75 per cent., or 20 per cent. more than he showed at the time of operation, his red blood cells are increased in number, his pigmentation has apparently diminished and he eats and lives with much less indigestion and abdominal discomfort. No splenectomy was performed on the other brother. His symptoms after two years seem to maintain themselves as largely related to the enlargement of the liver.

Dr. Allen O. Whipple said that these cases closely resemble two of his own cases of Gaucher's disease reported by Stout and Cushing. They were brother and sister and the sister had almost identically the same bone changes as those shown in the röntgenograms of Doctor Santee's cases. Following splenectomy, she was operated upon by Doctor Farley at the New York Orthopedic Hospital and the head, and a portion of the neck of the femur were resected. Sections from this tissue showed perfectly characteristic Gaucher cells. This patient has been followed now for four years and the restoration of function and apparent arrest in disease of the femur are remarkable. This girl is very active; she dances, she swims, she works. Of course, there is still shortening, but it shows very little. Following the splenectomy she has maintained her hæmoglobin and red cell count, she has lost pigmentation, and has maintained her weight. The arrest of the process in the femur cannot be explained, yet the patient is certainly a great deal better and healthier than she was four years ago.

Doctor Santee, in closing, remarked that one could look at Gaucher's disease as a disturbance in lipoid metabolism and that the condition should be viewed as such a disturbance rather than as a disease *per se*. The changes present are replacement changes in every way and if one could control lipoid metabolism in anyway, probably these changes could be controlled. It is difficult to see, however, how this end can be accomplished. It is remarkable how specifically the bone changes in the condition seem to pick out the head and neck of the femur for involvement, at least in the cases published. The condition is not incompatible with fairly long life, as is shown by the fact that some of these cases have gone well into fifty years before dying.

BRONCHOSTOMY COMPLICATED BY SEVERE HEMOPYTSIS

Dr. Howard Lilienthal presented a boy, thirteen years of age. His tonsils had been removed five years before under ether anæsthesia and six weeks later cough began with fever running to 103°, in December, 1923. Soon after he was operated upon by another surgeon for what appeared to be an empyema of the left chest, a rib resection being made high in the axilla. Much foul pus escaped. An intercostal counter incision was made low down in the back. A bronchial fistula developed at the upper wound, and gradually the discharge diminished and finally ceased, the fistula becoming skin lined and perfectly dry. Not until nearly five years after his operation were there any alarming symptoms but then there was sudden severe hæmorrhage both at the wound and by hemoptysis. Slight cough with repeated hemoptyses persisted. Doctor Lilienthal saw him September 29, 1928. He was well nourished but there were clubbed-fingers and there was a broncho-cutaneous, left axillary, fistula of large size. This fistula ran through the left fourth rib. There were no fluid levels and nothing suggestive of abscess, but neither was there any discharge from the bronchial stoma.

September 28, Doctor Lilienthal excised the skin about the fistula following it down to the hole in the rib. Then he resected this rib removing it from the chest wall and permitting the entire sinus with the skin about the fistula to slip through the opening in the bone. Dissection was made down to the lung and

then using the sinus as a handle he split the entire tract open down into the cavity within the lung. The walls were somewhat trabeculated and lined with mucous membrane. He then cut away about two-thirds of the wall of the abscess and burned the remainder with the actual cautery so as to destroy the epithelium. The wound was now packed with rubber dam, but the packing was placed not within the cavity but toward the mesial side of the abscess so as to compress its walls. A few days later the rubber dam was replaced by gauze and the dressings were changed daily. In a few weeks the wound was completely healed and the fistula closed. The patient remained well.

This case demonstrates the uncertainty of life with a broncho-cutaneous fistula. This condition should, except in rare instances, be regarded as a makeshift. The speaker knew of at least four cases in which, after more than a year, death has occurred from complications such as hæmorrhage or from spreading pulmonary gangrene after the patients had been regarded as out of all such danger. In closing fistulæ of this kind it is most important to obliterate the cavity or cavities into which they lead.

THE EVALUATION OF CERTAIN BLOOD-CLOTTING FACTORS IN SURGICAL DISEASE, WITH SPECIAL REFERENCE TO THROMBOSIS AND EMBOLISM AND CERTAIN BLEEDING CONDITIONS

Dr. Frederic W. Bancroft read a paper with the above title for which see page 161.

Dr. I. Newton Kugelmass, co-author of the paper, by invitation, said that this approach to quantitate the blood substances involved in the clotting mechanism in disease provided a means of determining whether a patient tends to bleed or to clot and hence the ability to diagnose more definitely the hæmorrhagic status of the patient which cannot possibly be ascertained by the present crude clotting time determination. The authors have been able to develop some simple methods of evaluating each of the substances involved in the clotting process, enabling them to characterize the bleeding or clotting tendency of a patient sufficiently in advance to be able to induct therapy in some and thus prevent thrombosis, and in others to overcome bleeding tendencies and make them favorable risks for operative procedure. These methods have been applied to potential hæmorrhagic disease of the new-born in utero by studying the maternal blood; to children suspected as bleeders preliminary to indicated tonsillectomy; to thrombocytopœnic purpuras and others with results as indicated by Doctor Bancroft. One of the striking developments of the work is the discovery of a relationship between diet and potential hæmorrhagic disease. The substances involved in clotting mechanism fall into two chemical groups from the standpoint of their nutritional precursors, the prothrombin and fibrinogen are globulins and the blood platelets are lipins. The authors have experimental and clinical evidence of being able to alter the hæmorrhagic status of a patient by diet. Those deficient in the protein or lipin substances were offered diets unusually high in pro-

teins and lipins and *vice versa*. They have thus developed two types of diets, the clotting diet, a régime concentrated in proteins and lipins, and a bleeding diet, consisting essentially of vegetables, fruits and carbohydrates. The indications for the type of diet depend upon the "clotting function index" introduced as a quantitative criterion of the hæmorrhagic status of a patient.

Doctor Bancroft, in closing, said the tests were started on the third and fifth days because he did not know how long ahead the changes in the blood would prognosticate the clotting tendencies. In one of the cases reported the clotting factors were normal on the fifth day and the patient developed a thrombosis on the eleventh; therefore the technic was recently changed and cases are now examined on the fifth and ninth days post-operative. In planning this work it was the original hope—and attempt is still being made—to find a simple technical test that could be done by any technician that will give a patient's clotting or bleeding time. It was due to this reason that the clinical cases have been repeatedly gone over, first with the analysis of prothrombin and then with fibrinogen, but it was not certain that either of these tests gave any clinical indication. Recently in a study of antithrombin it has seemed that perhaps this one test will prove to be an index of a patient's clotting tendencies. In certain cases the installation of a bleeding diet is difficult, and it is hoped that some such drug as heparin may be of service in these patients with clotting tendencies.

In answer to a question about the treatment of phlebitis: the treatment suggested by W. F. Shallenberger has been followed as outlined in a paper read before the Southern Surgical Association in 1924. He advised the injection of forty to fifty cubic centimetres of .05 per cent. gentian violet intravenously. About six cases have been treated by this method. In four there have been quite astonishing results—that is, there has been a quick return to normal temperature, pain has ceased almost immediately, and the swelling of the limb has apparently returned more quickly than would have occurred without this method of treatment. In one patient in four days the thigh had decreased in size two and a half inches in circumference. No ill results have been experienced by its use. Twice there have been chills, persisting for only a very short time. Doctor Stanley-Brown published an article in the *Surgical Clinics of North America* for August of last year reviewing these cases.

Further it would appear that a patient's clotting tendency can be diminished and therefore diminish the incidence of the disease. Trauma and infection and slowing of the blood stream are definite factors and therefore these factors do produce thrombosis. But some of these patients have all of these factors present and do not develop phlebitis, while others with minimum factors but with probably high clotting indices develop thrombosis. In one of these cases, a woman with a high clotting index developed thrombosis from merely resting her arm on a table. Following the clotting diet her index decreased and her

thrombin increased, so that on her return for follow-up, according to the blood examination she had bleeding rather than clotting tendencies.

STATED MEETING HELD MARCH 27, 1929

The President, Dr. Frank S. Mathews, in the Chair

NON-MALIGNANT INTUSSUSCEPTION OF TRANSVERSE COLON IN ADULT

Dr. Condict W. Cutler, Jr., presented a man, forty-seven years of age, who was admitted to the Lincoln Hospital on February 25, 1928, complaining of general abdominal pain, vomiting and diarrhœa.

Previously in good health, he began about a month before admission to complain of cramp-like pain in the abdomen. This pain was very persistent, was not localized, did not radiate and was not associated with meals. After the onset he was able to continue at work for a week, but then discontinued working because of the progressive character of his complaints. Two weeks before admission he began vomiting about ten to fifteen minutes after meals. The vomitus consisted of food just taken. Up to this time the bowels had been regular, but the stools now became diarrhœal following catharsis and continued so. Three days before admission the pain became more severe and spasmodic. The vomiting and diarrhœa also became more intense. The stools and vomitus were brown and fluid. The patient had never observed blood in either.

Upon admission the patient was quite prostrated. His temperature was 100, pulse 130. With the exception of a distended abdomen which was everywhere tender, though not rigid, the physical findings were not significant. There was a suggestion of resistance to palpation in the upper right quadrant, and slight rebound tenderness was referred there. The urine was normal. Blood count: white blood cells 14,000, polymorphonuclears 78 per cent.

As the diagnosis was not clear, further investigation was begun after the patient had been relieved of his vomiting by lavage and put on fluid diet. During the succeeding few days, however, the distention, cramps and diarrhœa persisted.

Tests of the stools with benzidine gave consistently positive reactions for blood. There was also considerable mucus in the passages. Gastric analysis was essentially normal in result. The Wassermann was negative. X-rays showed a stomach normal in size and without filling defect or retention. There was practically a stoppage of the barium meal in the ascending colon, the cæcum and terminal ileum showing marked distention. Barium enema showed obstruction distal to the hepatic flexure, though incomplete.

The patient was operated upon March 21. Exploration of the abdomen through a right rectus incision revealed a mass in the right upper quadrant. When adherent omentum had been separated from it this mass proved to be an intussusception of the first part of the transverse colon, just beyond the hepatic flexure. The mass was about the size of one's fist. The gut wall and surrounding intestinal coils showed evidence of active inflammation. The induration both of the affected intestine and adjacent mesentery was marked. There were several small firm glands in the mesentery suggesting malignant metastasis.

An attempt was made to reduce the intussusception with partial success, about three inches of intussuscipiens being withdrawn. When this was accomplished the suggestion of any extensive malignancy was much less marked, the gut appearing merely thickened and inflamed. On this account it was decided not to subject the patient to a radical colectomy but to perform a local resection of the Mikulicz type. The affected loop of intestine together with adjacent normal gut and its mesentery was eventrated and fixed in the usual manner, terminating the first stage.

Three days later the second stage, removal of the eventrated mass, was performed. A Kocher clamp was introduced to cut down the spur between the parallel lumina of the ascending and transverse colon.

Pathological examination of the removed portion of gut and of its mesentery showed no evidence of malignancy. The firm nodular mass of the gut wall which had formed the apex of the intussuscipiens showed hypertrophy of the mucosa and marked chronic and acute inflammatory changes with superficial ulceration but no carcinomatous change. The other coats of the intestine showed corresponding pathology.

The patient, relieved of his symptoms, progressed satisfactorily. The spur was cut down joining the lumina and bowel movements began about one week after the second stage. June 6 closure of the peristent fæcal fistula was done. To avoid peritoneal contamination the gut at the site of the stoma was not separated from the abdominal wall, but was tightly closed *in situ* and the muscles and fascia united over it in their normal relations. Healing occurred without leakage, and the patient was discharged two weeks later in good condition. He has been well and gaining in weight since that time.

HÆMORRHAGE FROM MIDDLE MENINGEAL ARTERY

Doctor Cutler presented also a woman, thirty-nine years of age, who was admitted to the First Surgical Division of the Roosevelt Hospital December 14, 1928.

Forty-eight hours prior to admission the patient, while standing at the head of the stairs fell without determined cause and was found lying unconscious at the foot of the stairs. This condition of unconsciousness persisted for a few moments. Upon recovering it was noticed that her left arm was held in a peculiar position and seemed weak. She was put to bed and seemed rather dazed, but could be readily aroused. She subsequently improved, but on walking there was noted to be a definite weakness in the left leg while the left arm also continued weak. Twelve hours before admission she lost consciousness completely and her condition had become progressively worse since that time.

When admitted she was in a stuporous condition and tossing restlessly in bed.

Examination of the head showed a moderate hematoma in the right side of the scalp above the mastoid region. The eyes showed contraction of the right pupil as compared with the left and distinct divergent strabismus. The pupils reacted to light, but sluggishly. Ophthalmoscopic examination was difficult because of the constant rolling of the eyes, but there seemed to be some slight haziness in outline of the discs. There was no apparent paralysis of the face muscles and no marked twitching. In her uncoördinated movements the patient used both the left arm and left leg, but muscular resistance in the arm in particular was distinctly weaker than on the right side. The

reflexes at the knee were exaggerated, but apparently equal on both sides. There was no rigidity of the neck or Kernig sign.

Her temperature on admission was 100.8°, respirations 32, pulse 78, blood pressure 125/70.

An X-ray picture of the skull did not show a definite fracture at the first examination, but this was not conclusive because of the difficulty in keeping the patient's head quiet during exposure.

A lumbar puncture was done and six cubic centimetres of uniformly bloody fluid was obtained under normal pressure.

Subsequently, upon the day of admission, 150 cubic centimetres of 50 per cent. glucose were administered intravenously and there seemed to be some slight improvement on the following morning. During the day, however, the patient became more stuporous and the breathing somewhat stertorous in type, and movements in the left arm and leg were gradually lost, as also was the activity of the face muscles on the left side. Definite choking of the optic discs was now observed and a diagnosis of extradural hæmorrhage with fractured skull and laceration of the middle meningeal artery was made. December 16 the patient was operated upon. She was completely comatose and no anæsthesia was necessary. A button trephine was done over the bifurcation of the anterior branch of the right middle meningeal artery. A considerable amount of clot was discovered beneath the skull extending in all directions in the parietal region. A temporal decompression was then proceeded with and a flap of bone turned down. Its removal revealed a large blood clot perhaps amounting to about six ounces and covering most of the anterior right hemisphere. Active bleeding was coming from the middle meningeal artery and this was temporarily controlled with packing. The clot was removed and the dura beneath found not to have been torn. It was, however, very markedly depressed and the brain tissue beneath it felt very soft and almost fluctuating. Attempt was now made to control the bleeding which apparently came up from the area below the base of the flap. In order to secure the bleeding point the opening was enlarged downward with a rongeur so that the inner table could be inspected all the way to the base of the skull. No definite point of bleeding could be observed, but blood continued to well up from the base in the neighborhood of the foramen spinosum. As no specific bleeding spot could be isolated, a small strip of packing was introduced into this region, which, with moderate pressure, eventually controlled the bleeding. This packing was brought out at the lower angle of the wound anteriorly and flap of elevated bone, muscle and scalp replaced.

Following the patient's return to the ward there was a distinct hyperpyrexia, her temperature reaching 107°. This was associated with marked shock and the blood pressure fell to 70/45. She responded, however, to the treatment employed for shock and by the following day showed distinct improvement. Within twenty-four hours after operation the patient was entirely conscious although a little confused. She was able to use the muscles of the left side, face, arm and leg at this time. During the succeeding days the improvement continued. The slight discharge from the wound subsided following the removal of the packing on the third day. She was allowed out of bed on the twenty-seventh post-operative day feeling entirely well. Since that time the patient has continued in excellent health and has had no symptoms of weakness of the arm or leg and no alteration from her normal mentality.

OSTEOMYELITIS OF JAW

DOCTOR CUTLER presented also a man, thirty-three years of age, who was admitted to the Lincoln Hospital May 26, 1928. Ten days previously he had begun to have pain and swelling at the left side of the jaw. Two days after onset a left lower molar was extracted, and as the swelling did not subside his dentist had made several incisions within the mouth near the site of extraction. The pain and swelling increased, however, and when the patient was admitted there was a tense and brawny induration of the left lower cheek and side of the neck. There was also marked swelling within the mouth, suggestive of alveolar abscess, and from the site of extraction there was a thin purulent discharge. The mouth could be opened but one-half inch.

At this time the patient's temperature was 102°, pulse 106. He seemed very sick and was markedly prostrated. Urine was normal. Blood count: white blood cells 18,000, polynuclears 80 per cent.

On the day following admission an incision was made in an area of softening beneath the ramus of the left jaw and pus obtained. The alveolar abscess was also opened. Subsequent incisions were made as localizations of the process or pocketing occurred. For a period of nearly six weeks the patient's temperature continued of the septic type, ranging from 99° to 103° or 104° daily. During this period several transfusions were given. Blood cultures showed no growth. The patient was so depleted and septic that it was feared he would not survive. The temperature began to subside, however, and by the middle of July had reached normal and the patient was up and about with numerous draining sinuses about the jaw and neck.

At about this time the removal of sequestra from the jaw began. As fragments of the bone became demonstrably loose or were shown by X-ray, they were removed, the sinuses being frequently enlarged for the purpose. This process continued until in October, the total fragments removed approximating a considerable portion of the lower jaw. The sinuses closed until at the present time but one remains discharging. There is at the bottom of this a small sequestrum which requires removal.

On November 17 the patient was discharged to the dental clinic for removal of the dead teeth and splinting of the jaw. From just below the articulations no solid bone was palpable at this time, and in fact for a considerable period of time, while disintegration of the jaw was progressing, there was no stability to the structure. It was assumed that following a dental clearing of the mouth and after an appropriate period for the subsidence of exudate some grafting procedure would need to be attempted.

X-ray pictures which were taken about one month later showed some evidence of bone regeneration. This regeneration has been progressive to the present time, and now has developed a fairly stable bony structure. It is now possible for the patient to use his jaw a little, and he opens his mouth about one inch. The removal of dead teeth and the application of an appropriate dental plate will improve his function considerably.

LARGE RETROPERITONEAL LIPOMA

DR. DEWITT STETTEN presented a man, forty-three years of age, who was first seen by him December 5, 1923. He had been examined the week previously for life insurance and a growth was discovered in the lower abdomen. There were no symptoms. The patient had not lost any weight. On examination a large, ovoid, fluctuating mass was felt, filling the right lower quadrant of the abdomen, extending as high as the umbilicus, and somewhat to the left of the median line. It was insensitive and there was no rigidity. It was dull to percussion. The mass felt very much like a large cyst, possibly

of mesenteric or omental origin. Rectal examination was negative. On catheterizing the patient and emptying the bladder, no effect was noted on the size or shape of the mass. X-ray examination showed no defect in the large intestine, but the cæcum was displaced upward and to the left by the tumor. December 11, 1923, an operation was done. A median incision was made, and a large retroperitoneal, yellowish tumor was found, which had pushed the cæcum upward and inward, and the posterior parietal peritoneum forward so that this had become attached and adherent to the lower leaf of the mesentery of the terminal ileum. There was a small, kinked and twisted appendix with a club-shaped tip, bound down by adhesions between the tumor and the cæcum. The tumor was distinctly encapsulated and obviously lipomatous in character, springing apparently from the retroperitoneal fat in the region of the brim of the pelvis near the right sacro-iliac joint. There was a lobulated prolongation posteriorly near the upper pole. The tumor was enucleated without much difficulty by splitting the posterior parietal peritoneum over it, and then dividing the capsule of the tumor. It was moderately adherent at the lower pole and at the lobulated prolongation posteriorly near the upper pole. There was very little bleeding. The appendix was removed in the usual fashion. The tumor (Fig. 1) measured twenty-two centimetres in length, twelve centimetres in width, and nine centimetres in thickness, and weighed 710 grams. It was encapsulated and there was a small lobulation of the upper pole posteriorly. It was rather firmer and more fibrous than the usual lipoma. On microscopic examination the tumor was found to be an ordinary lipoma, composed of mature fat cells, with no suggestion of malignancy. The convalescence was uneventful and the patient has remained perfectly well since.

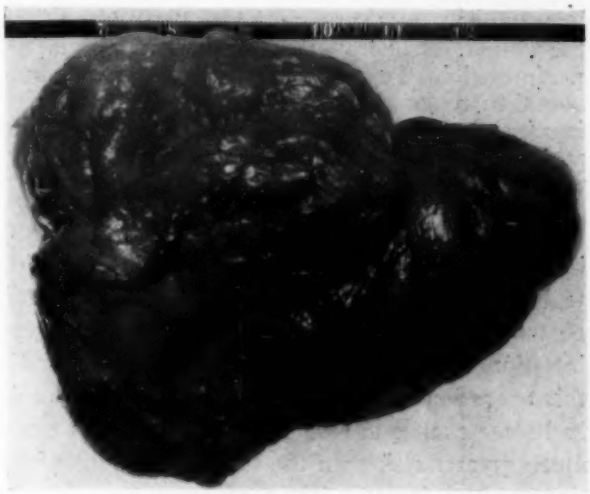

FIG. 1.—Large retroperitoneal lipoma.

STRANGULATED FEMORAL HERNIA WITH GANGRENE OF ILEUM IN SEVENTY-NINE YEAR OLD PATIENT

DR. DEWITT STETTEN presented a woman, eighty years of age, whom he first saw on October 15, 1927. For twenty-five years the patient had had a hernia in the right groin, which had always been reducible, and which never had been previously incarcerated. A truss had been worn until five years ago. About twenty hours previously patient developed abdominal cramps and vomiting which continued in spite of an effective enema. About three hours before Doctor Stetten's examination, she noticed that the swelling of her right groin had become irreducible. The examination disclosed a hard, sensitive, globular swelling in the right groin, the size of a small orange. It was irreducible and tympanitic on percussion. The patient's condition was good. The temperature was normal. The pulse was 80, regular and of good

quality. The presence of a right strangulated femoral hernia was evident. The patient was immediately transferred to the hospital and operated upon under local anæsthesia. In the hernial sac was found a four inch loop of ileum, dark bluish-black in color. In spite of about twenty minutes' nursing with hot saline wipes, there was only slight improvement in the appearance of the strangulated loop, although the peritoneum was glossy and there appeared to be some peristalsis. It seemed rather certain that the loop would not recover, but owing to the patient's age a primary resection was deemed inadvisable. The loop was therefore drawn out on the abdominal wall until undoubtedly healthy intestine protruded beyond the peritoneal cavity; gauze tampons were packed around the loop. The patient ceased vomiting immediately upon the relief of the constriction. After the lapse of nineteen hours examination showed advanced gangrene of the strangulated loop. The patient was again operated upon under nitrous oxide-oxygen-ethylene anæsthesia. The tampons were removed and the healthy ileum brought further out into the wound. Deliberate resection with a lateral isoperistaltic ileo-ileostomy was performed in the usual manner. The anastomosed portion of the intestine was then replaced into the abdominal cavity, a modified Lotheissen femoral-inguinal hernioplasty was done according to the method described by the author. The patient's convalescence was entirely uneventful and the wound healed by primary union.

Doctor Stetten presented this case to demonstrate a plan of procedure in strangulated hernia with intestinal gangrene in the aged, which he believed to be worthy of commendation. By dividing the constriction, the intestinal obstruction and shock are relieved. The danger of primary resection, with intestinal anastomosis and hernioplasty is certainly reduced by performing this operation after an elapsed period of time, during which the patient has had some chance to recover. This method is certainly preferable and without much greater risk than the usual procedure of removing the gangrenous gut that has been brought into the wound, leaving the resultant ileostomy for subsequent closure and then performing a secondary hernioplasty.

Dr. Howard Lilienthal said that in hernia when gangrene is present, even though the constriction has been removed, the process may after all be progressive and there may be spots of gangrene quite a distance from the primary necrotic area. Consequently, to avoid danger, he preferred to cut off that loop of the gut as soon as possible. He has used a method exemplified in the following case: A little, thin, old woman had strangulated hernia with gangrene of the ileum. Doctor Lilienthal enlarged the opening, withdrew the gut until practically certain that nothing was left within of the gangrene, placed half a Murphy button into each side of the loop through an opening in the gangrenous part, made a minute incision over the stem of each button and forced the two together. No suture was necessary, overlapping or otherwise. The walls of this gut were thin. The strangulation was so acute that there was no hypertrophy of the gut walls. He crushed the gut walls the same as he is in the habit of crushing the root of the appendix; ligated over the place where the clamp had crushed the two legs of the loop about an inch and a half away from the Murphy button, which was now closed, and insured immediate passage of gas and liquid stool; cut the ileum

off and carbolized the stumps thoroughly. The silk ligature was left with its ends in the wound and the remainder of the hernia was pushed back far enough to make sure it was in the abdomen, strapped there and left. It was seven or eight days before the ligature came away with the stump and there was at no time leakage or other trouble. The button came away in due time and the patient was entirely cured. In feeble, vomiting, old individuals, when one wishes to finish the operation as quickly as possible, this is a good method and there is as little danger connected with it as there is in any other procedure with the same object. Contact has been established, not only the gangrenous loop has been gotten rid of but the unhealthy tissues intimately connected with it. The danger point is near enough to the opening in the abdominal wall so there need be no fear if there should be some accident at the point where the ligature was applied.

Dr. Richard Lewisohn referred to a patient whom he had presented before this Society in 1926. He had operated on the man in 1920 for strangulated inguinal hernia of six hours' duration. The patient was eighty-two years of age at the time of operation. Parts of the transverse colon were completely gangrenous and he performed a primary resection. The man, aside from pneumonia, made an uneventful recovery. These old people, when they are in good general condition such as absence of marked pathology in heart, lungs or kidneys, are not very grave operative risks. In view of the fact that Doctor Stetten was doubtful as to the viability of the strangulated intestine, "vorlagerung" was the correct procedure. In the presence of definite gangrene, primary resection would be preferable to a two-stage operation.

Doctor Stetten in closing said that he had presented this case just because he thought it illustrated the value of not doing a primary resection in these cases. It is true that at the time of the first operation he was slightly doubtful of the condition of the gut and that he thought that there was a possibility that it might recover. Nevertheless, he believes that even if the certainty of gangrene is present it would be advisable to follow this procedure and not do the resection until a later date when the patient has recovered somewhat from the shock and obstruction after the constriction has been relieved. He thinks that by this means the risk of operation and the mortality might be reduced. Although his patient was in good condition at the time of the first operation and might have stood a primary resection, she ceased vomiting immediately after the release of constriction and was in still better condition at the end of the nineteen hours when the resection was performed.

As to the possibility of gangrene extending further along the intestine, in this case this was out of the question, as the ileum was brought out on the abdominal wall well beyond the gangrenous area. He felt that this danger could easily be overcome and that there was no particular need for worry about absorption from the loop of extra-abdominal intestinal gangrene when well walled off by tampons and only left for a relatively short period of time. A similar situation is frequently met with in the Mikulicz "vorlagerung"

operation where the mesenteric vessels must be ligated. Here there is never any trouble provided the gangrene which follows the arrest of the circulation is entirely extra-abdominal.

FIG. 2.—Radiograph twenty-four hours after motor meal showing arrest of meal in right side of transverse colon.

SUBMUCOUS LIPOMA OF TRANSVERSE COLON WITH RECURRENT INTUSSUSCEPTION

DR. DEWITT STETTEN presented a woman, forty years of age, who first came under his observation February 5, 1929. She gave a history of having had during the previous seven weeks repeated attacks of severe cramp-like abdominal pain with rather vague localization. The pain apparently started somewhere in the left lower abdomen and radiated all over the abdomen, to

both shoulder blades and down the inner side of the left thigh. The patient belched frequently and vomited at times during the attacks. The bowels were constipated and occasionally there was mucus in the stools but never any

FIG. 3.—Radiograph after barium clysma showing sharply outlined, smooth, oval defect in right side of transverse colon.

blood. There had been no jaundice nor urinary symptoms. In the past four months, the patient had lost about fifteen pounds in weight. The patient was a well-nourished woman who did not appear acutely ill. The abdominal examination revealed no masses, sensitiveness nor rigidity. X-ray examination showed that the motor meal was definitely arrested in the twenty-four-hour film at a point just to the right of the midtransverse colon. The intestine was not dilated. (Fig. 2.) The barium clysma the following day disclosed a persistent, sharply outlined, smooth, oval defect about the size of a

large egg in the right half of the transverse colon. Although this defect shifted slightly in the films, it appeared to remain in relatively the same position. It seemed to be free at its left side, but apparently fixed to the right.

FIG. 4.—Radiograph after defecation following barium clysma showing retention of barium in appendix, cæcum, ascending colon and right side of transverse colon, with relative emptying of balance of large intestine.

(Fig. 3.) This was confirmed by fluoroscopy. After defecation the portion of the colon distal to the defect emptied relatively well, while that proximal remained quite filled. (Fig. 4.) A second barium clysma given two days after the first again showed the oval defect very distinctly. It had moved somewhat further over to the left and on this second examination the clysma

seemed to be almost completely obstructed at the defect. The slight amount of barium proximal to the defect was apparently retained from the previous motor meal and the previous clysma. (Fig. 5.) As a result of the X-ray

FIG. 5.—Radiograph after second barium clysma showing almost complete obstruction near mid-point of transverse colon and persistence of oval defect. Slight amount of barium in right side of transverse colon, ascending colon, cæcum and appendix due to retention from previous motor meal and previous clysma.

studies a diagnosis of pedunculated benign tumor of the right side of the transverse colon with partial intestinal obstruction was made. It was thought that the tumor was probably a submucous lipoma and that the attacks of pain and vomiting were attacks of partial obstruction due either to simple obturation from the tumor or more likely still to recurrent intussusception.

The patient was operated upon February 7, 1929, under general anæs-

thesia. Through a median epigastric incision, the transverse colon was drawn into the wound, and in its right half, exactly in the position indicated by the X-ray, was found a smooth, firm, freely movable, ovoid pedunculated tumor, the size of a large egg, attached by a broad pedicle to the lower posterior wall of the gut. There was considerable infiltration around the base and the adjacent mesentery, where there also could be felt numerous enlarged, hard lymph glands. As the tumor had the characteristic feel of a benign growth, it was assumed that this infiltration and the enlarged, hard lymph glands were due to an inflammatory reaction, possibly because of a recurrent intussusception which had reduced itself spontaneously. A transverse incision was made through the upper posterior wall of the colon. The tumor was found to be in the submucous layer and had all the gross characteristics of a benign growth. The mucous membrane over the free half of the tumor was gangrenous and ulcerated. The pedicle was circumcised at its base and the tumor excised, the mucous membrane defect being closed with a double row of sutures. The colotomy wound was closed in the usual manner by a triple layer of sutures without narrowing the lumen of the gut. The omentum was laid over the suture line and sutured in place. The abdomen was closed by the usual method without peritoneal drainage. The patient's convalescence was entirely uneventful, the wound healing by primary union except for a slight subcutaneous suppuration at the lower angle, through the skin drainage opening which rapidly cleaned up. She has been free of symptoms since the operation.

FIG. 6.—Subcutaneous lipoma of transverse colon with gangrene and ulceration of mucous membrane of free half (to left).

The tumor was a smooth, firm, ovoid mass the size of a large egg, covered by mucous membrane of which the apical half was gangrenous and ulcerated. This gangrene and ulceration may have accounted in part for the infiltration of the mesentery and the apparently inflamed mesenteric lymph glands. On section it was found to be a rather firm, fatty growth, characteristic of a submucous lipoma.

The case is presented mainly to show that it is possible today, with the aid of careful X-ray studies, to make a pre-operative diagnosis of this relatively rare condition. Twenty years ago, Doctor Stetten, on the basis of two personal cases, published a paper entitled, "The Submucous Lipoma of the Gastro-intestinal Tract" (*Surgery, Gynæcology and Obstetrics,* August,

vol. ix, pp. 156–175, 1909). In this paper he made a complete analysis of the literature up to that time and found that seventy-seven cases had been reported from all portions of the gastro-intestinal tract, of which thirty-four were in the colon, excluding the rectal cases. In fifteen of these an intussusception occurred—nine chronic and six acute. It is curious to note that in this paper there is no reference whatsoever to X-ray studies as a diagnostic measure. Of course twenty years ago the radiographic study of gastro-intestinal lesions was in its infancy, and although studies of the stomach were beginning to be made, the intestine was still considerably neglected for a number of years. When the paper was published, a definite, correct, pre-operative diagnosis was regarded as an almost impossible achievement. As a result of the strides that have been made in intestinal radiography in the past years it must be admitted that the exact diagnosis in this case was neither fantastic nor difficult, but rather obvious. Its mobility definitely suggested the pedunculation and even the probable pre-operative diagnosis of the pathology of the tumor was not so far-fetched, as it is well known that the submucous lipoma is by far the most common form of benign growth in this region.

Dr. John Douglas said there were two reasons perhaps why correct diagnosis in this case had been possible. One, that Doctor Stetten had had a similar case before and that helps in making a diagnosis of rare conditions. The other, that it was a submucous tumor. These lipomata of the large intestine are not always submucous. Some two or three years ago Doctor Douglas said he had shown before the Society a case of lipoma of the large intestines. The tumor was not pedunculated in this case. An X-ray of the colon was taken. In the radiograph the shadow was exactly that which would be shown by a carcinoma and it was not until a section of the sigmoid had been removed and an anastomosis done and the gut cut open afterward that the fact that it was a lipoma rather than a carcinoma could be recognized.

Dr. Frank S. Mathews recalled a case with pelvic tumor well circumscribed and suggesting an ovarian cyst. It was, however, attached to the wall of the pelvis. At operation it proved to be a lipoma, for the most part easily enucleated, but it extended downward and evidently had its origin in the femoral canal.

Dr. Hermann Fischer said that these retroperitoneal lipomata are sometimes of tremendous size. Although they are benign tumors they have the tendency to recur. There are on record several of these tumors that have recurred two and even three times. They are potentially malignant as they can endanger the life of the patient by their huge size and the difficulty of their removal. Every case of retroperitoneal tumor ought to be carefully watched for possible recurrence.

RADICAL AMPUTATION OF BREAST FOR CARCINOMA AFTER CLOSURE OF LARGE DEFECT

Dr. DeWitt Stetten presented a woman, forty years of age, whom he first saw March 15, 1928. She had noticed a growth in her right breast for nearly a year. This had been growing rather rapidly for about four months.

Examination disclosed a large, irregular, hard tumor in the outer upper quadrant of the right breast extending toward the axilla. The tumor was firmly and broadly adherent to the skin, and in the axilla several large, hard lymph glands could be palpated. The patient was operated on March 21, 1928, the usual radical amputation of the breast being performed. Owing to the extensive skin involvement, a very wide skin excision was necessary, especially laterally, so that there was an extremely small axillary flap left and a very large resulting defect, which, even with extensive undermining and mobilization of the skin of both sides, could not be closed. Instead of doing a Thiersch graft on this defect which has the disadvantage of leaving a very thin, delicate scar directly over the ribs, lateral crescentic incisions were made on each side some distance away from the wound edge to relieve tension. After this was done the main wound could be easily closed without tension and the gaps produced by the lateral crescentic incisions were tamponed with gauze. The patient made an uneventful convalescence and the sutured portion of the wound healed by primary union, both medial and lateral flaps maintaining excellent nutrition. The gaps produced by the lateral incisions granulated nicely and on April 9, 1928, these granulating areas were successfully Thiersch grafted. Doctor Stetten presents this case to demonstrate what he considers a practical method of closing large defects after radical amputation of the breast. The scar from the main wound is a linear one, and there is a normal skin covering over the ribs. Function of the arm was rapidly restored almost to normal except for a slight restriction to backward motion when the arm is elevated. Doctor Stetten believes that this method is superior to the grafting of the original defect as it leaves a normal skin covering with its pad of subcutaneous fat over the anterior and more exposed portion of the chest and in no way increases the disturbance of function of the arm. Of course the Thiersch grafting of the lateral gaps could be done as a primary measure. This perhaps may even be more advisable than doing it as a secondary procedure, as was done in this case.

Dr. Richard Lewisohn said that the Kocher incision, as used by Doctor Stetten, required plastic surgery in a large number of cases. With the Stewart incision, which is now the incision of choice of a number of surgeons at Mount Sinai Hospital, the skin can always be sutured without undue tension and without resorting to plastic correction. For this reason, the Stewart incision, aside from its better cosmetic effect, is preferable to the Kocher incision.

Dr. Alexis Moschcowitz said that personally he objected to the Stewart incision for a radical amputation of the breast. When he heard Doctor Stewart read his paper describing the new incision, he was the first one to use it, but after trying it out on a few cases, he abandoned it. While cosmetically, very beautiful, he has never had as perfect an exposure as with the ordinary incision extending a short distance down the arm; on that account, he is afraid of being less radical than with the ordinary incision.

HERNIA THROUGH THE FORAMEN OF WINSLOW

Dr. John Douglas presented a man, fifty-three years of age, who had an attack of severe pain during the night of October 26, 1927. The pain began in the region of the navel and then located in the epigastrium. He vomited for four hours that night and the most severe pain was then relieved.

He was admitted to St. Luke's Hospital on the morning of October 27. There was no elevation of temperature or blood count, no rigidity or loss of liver dulness, and only moderate tenderness in the epigastrium.

The following day the radiographs showed quite obviously a displacement of the pylorus and duodenal cap to the left with a defect along their right margins (see Figs. 7, 8, 9), and a loop of small intestine which apparently had passed through the foramen of Winslow into the lesser sac. At the end of six hours the stomach was emptied, but the shadow of this loop of small intestine could still be seen, distended with gas, occupying the same location and well above the transverse colon, which was outlined by the bismuth filling it. This was also shown, but less plainly, in a twenty-four-hour film. Therefore, a diagnosis was made of hernia through the foramen of Winslow.

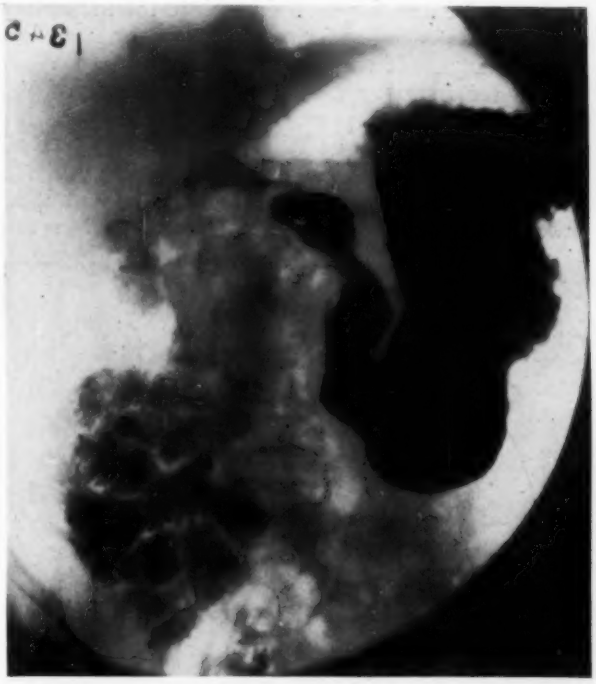

FIG. 7.—Hernia through the foramen of Winslow five minutes after barium meal. Note deformity of pylorus and duodenum and loop of small intestine in lesser sac.

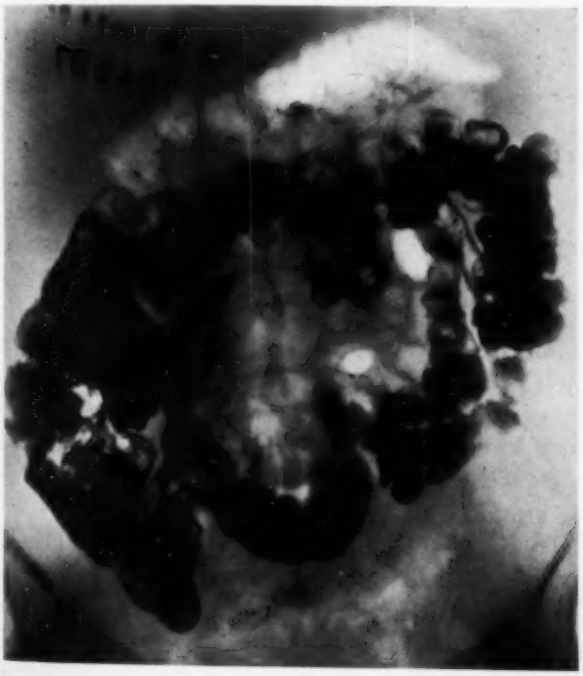

FIG. 8.—Hernia through the foramen of Winslow six hours after meal. Note air-filled loop of small intestine in lesser sac continuous with barium-filled loop below.

Operation was performed the following day, there being no obstruction apparent in this loop of small intestine. At the time of operation no intestine was found occupying the lesser sac. However, a loop of ileum, ten inches long and about two feet from the ileocæcal valve, was found, at both ends of which could be easily demonstrated a narrow compressed area completely encircling the in-

testine and extending well down into the mesentery, such as one sees in a loop of intestine which has been pulled out of a hernial sac after it has been pinched by the margins of the ring. The foramen of Winslow admitted three fingers. As a later radiograph showed the absence of this shadow, it would appear from the evidence present that this loop of intestine had been herniated through the foramen of Winslow into the lesser sac.

It being impossible to narrow the foramen of Winslow on account of its surrounding structures and as the loop of intestine had apparently passed either to the right of the hepatic flexure or in front of the transverse colon, an attempt was made to prevent a recurrence of the lesion by causing adhesions between the greater omentum and anterior abdominal wall, so that the small intestine could not again pass in front of the transverse colon. Since the time of operation, seventeen months ago, the patient has had no recurrence of his symptoms.

FIG. 9.—Hernia through the foramen of Winslow. Twenty-four-hour film. Note air-filled loop above colon.

In May, 1924, the speaker reported a case of hernia through the foramen of Winslow in the *Journal of the American Medical Association*. At that time there had been collected by Ullman thirty cases from the literature. My case then recorded was the thirty-first case in the literature and the third case in the American literature. Since then, a number of cases have been reported, one series by Dewis and Miller, who added to Ullman's group one case of their own and two additional cases not reported by Ullman, making a total of thirty-three cases, not including the case previously reported by me. In a rather superficial search of the literature since then, I have found three additional cases reported—one by Shapiro, one by Carling and Smith and one by Green. These, together with the case here reported and the one previously reported by me, make a total of thirty-eight cases.

The excellent articles and a review of the literature published by Dewis and Miller, and also by Ullman, make it unnecessary to again go through this part of the subject. However, while it is recognized that the occurrence of a hernia through the foramen of Winslow usually causes symptoms of acute strangulation and necessitates immediate operation, it was the disappearance of these acute symptoms which made possible the radiographic

examination in this case which allowed a diagnosis to be made, which would, of course, be impossible in the presence of acute symptoms. As it is stated in one article on the subject that a diagnosis of this condition has never been made before operation and rarely even suspected, it seemed worth while to report this case in which the diagnosis was made previous to operation, for although the intestine was not found in the lesser sac, there was ample evidence of its having been there at the time the radiograph was taken.

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ENDOMETRIOSIS OF THE SIGMOID—INTESTINAL OBSTRUCTION

Dr. John Douglas presented a woman, forty-four years of age, who was in good health until September, 1928, when she had an attack of abdominal pain with distention. Bowels moved only with repeated enemas. This attack was followed by obstinate constipation and considerable loss of weight. October 24, she had another attack of severe and acute abdominal pain with passage of a small amount of gas and fæces only effected by enemas, colonic irrigations and the use of pituitrin. The patient vomited and presented all the evidence of an obstruction of the sigmoid. At no time was there any blood in the stools. A barium clysma verified the diagnosis of obstruction in the sigmoid flexure.

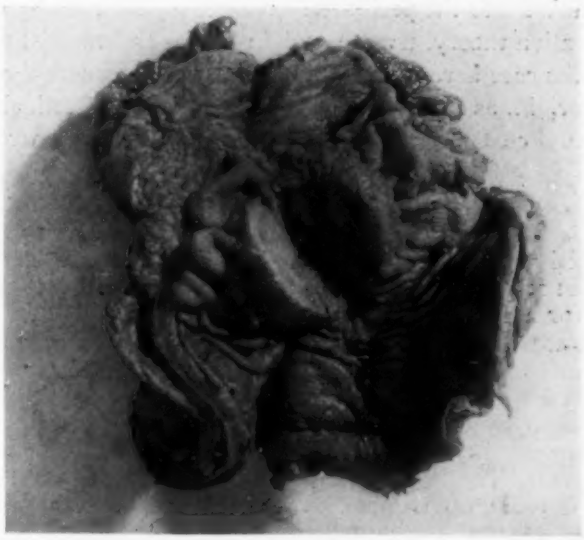

Fig. 10.—Endometriosis of sigmoid. Tumor incised and laid open.

November 1, the first stage of a Mikulicz operation was done, with resection of the growth and about twelve centimetres of intestine. The protruding ends of the intestine were left clamped after suturing the proximal and distal limbs together to establish a spur. The tumor (Fig. 10) causing the obstruction of the intestine was 2.75 centimetres in diameter and was situated in the mesenteric side of the sigmoid. There was no ulceration of the mucosa. For this reason, it appeared that the growth was not a carcinoma. A Mikulicz clamp was applied to the spur on the sixth day following operation, and the colostomy closed November 21. The patient was discharged December 8, eighteen days later.

The pathological examination showed the tumor to be made up of endometrial tissue.

In 1893 Von Recklinghausen discussed endometrial adenomata and suggested that they might arise from embryonic rests derived from the Wolffian body. Since then, many cases have been reported in the medical literature of endometriosis occurring primarily in the abdominal wall or in postoperative scars, following operations on the uterus or adnexæ. They have been reported as occurring in the rectovaginal septum, in the peritoneum, particularly in the pelvic peritoneum, and in the wall of the intestine. The pathological records of St. Luke's Hospital, beside the case here reported, show two of the appendix, one of the small intestine and one occurring in an abdominal scar.

Much interest in the subject has been stimulated during the past few years by the work of Samson, whose report of cases, together with the experiments of his co-worker, Jacobson, has been particularly directed to the implantation theory of origin. According to Samson's belief, peritoneal endometriosis arises from endometrial epithelium passing out from the patent tubes into the peritoneal cavity. It is believed by others accepting the implantation theory, that the origin of the endometrial tissue is from the ovary. In the case here reported it is difficult to assume the implantation theory for its origin, as the tumor was situated in the intestinal wall well below the peritoneal coat, and the theory of an embryonic rest would better explain its origin.

OSTEITIS FIBROSA OF TIBIA

Dr. John Douglas presented a boy, seven years of age, who was admitted to St. Luke's Hospital October 26, 1927. Three weeks before admission, he fell and struck the anterior aspect of his left tibia on a stone. It hurt him for a day or so but caused no abrasion and there were no further symptoms until one week later when his mother noticed a swelling in this area which was at this time neither red nor tender. A radiograph showed an area of rarefication at the junction of the upper and middle third of the tibia. This was curetted out after chiseling off the anterior surface, and a fragment of the cortex, after carefully removing all of the endosteum, was inserted as a graft. The cavity entirely filled in after several months as shown by a series of radiographs taken over this time.

He was readmitted to the hospital January 30, 1929, fifteen months after the original operation. In the interval he had been free of pain, except for an occasional ache in the leg in wet weather, until the day before his admission when he had a sharp pain slightly higher than the original area. A radiograph at this time showed the original area occupied by the cyst, now filled in by dense and compact bone, and the outline of the original graft could still be distinguished. Just above the original lesion, however, there was again shown a rarefied area which extended about 2.5 centimetres above the old lesion.

January 31, the bone was again chiseled away from the surface of this area which was the site of a lesion similar to the one that had occurred before. There was no cyst but there seemed to be two distinct areas in the pathological process, one of which was occupied by a dense, fibrous tissue, the other showing considerable calcification with the formation of new bone.

This area was again chiseled out and filled with chips of bone removed from the cortex, which were carefully scraped so as to remove any endosteum or any bone which appeared diseased. He has again healed up and a radiograph taken a few days ago shows considerable calcification and regeneration in this area.

The patient was shown to demonstrate a repair of the original area of osteitis fibrosa by means of curetting together with insertion of a graft, and the development of a new area of the same process above and apparently continuous with the old lesion.

FRACTURES FROM OSTEITIS FIBROSA OF HUMERUS

DR. JOHN DOUGLAS presented a boy, thirteen and a half years of age. Four and a half years ago, June, 1924, he was struck on the right arm with some school books swinging on a strap. This caused a fracture of the upper third of the humerus. The fracture healed with deformity, and three months later, September, 1924, was refractured. He was told later that a bone cyst was present and an operation was advised. The bone was curetted in April, 1925, and in September, 1925, it was stated that he had a third fracture after a comparatively trivial traumatism. Since then he has had a number of X-ray treatments with moderate voltage of 100 to 130 kilovolts. March 1, 1929, while throwing a baseball, he again fractured his right humerus. This time the fracture, which was a spiral one, (Fig. 11) apparently started below the area shown by the X-ray to be occupied by the bone cyst which involved somewhat more than the upper half of the humerus, extending above almost to the epiphyseal line. The whole shaft, however, involved in the line of fracture appears rarefied. Doctor Douglas desired advice as to the line of future treatment after the healing of this fracture, as it would appear, in view of his operation and four fractures, that any operative procedure for the curetting and removal of the diseased area, together with the application of a graft, would necessarily be a very extensive one and would involve considerable danger of injury to the musculospiral nerve.

FIG. 11.—Case IV.—Osteitis fibrosa cystica. Pathological fracture.

DR. ROBERT T. MORRIS said that although he would not like to take the responsibility of advising a certain experimental method, yet if this young man were willing to do without the use of the humerus for a year, the entire diaphysis of the humerus might be removed, leaving the periosteum. He would probably get regeneration from the periosteum and eventually have new, healthy bone.

DR. MORRIS K. SMITH said that he had had occasion to treat a girl of eleven for her third pathological fracture of the upper end of the right femur. The underlying condition was osteitis fibrosa. He examined this patient about

ten years later. She had had no subsequent fractures. There was marked shortening of the extremity. Doctor Douglas had called attention to the apparent new bone formation in the cyst in his case and Doctor Smith wondered whether an eventual cure as far as strength of the arm was concerned might not be anticipated if the patient were not operated upon.

Dr. Hermann Fischer said that many years ago he observed a case, together with Dr. Frederick Kammerer, of an extensive osteofibrosis which had its seat in the diaphysis of the femur. The femur consisted of a mere shell of bone with a complete fibrosis of the cancellous tissue from the greater trochanter down to the condyles. The man had suffered a pathological fracture in the middle of the femur which was the first symptom of the disease in this case. All the diseased tissue in this case was removed. The man finally left the hospital with a consolidated fracture and a useful leg. He thought Doctor Douglas' case should be operated upon. One need not fear an injury to the musculospiral, if it is carefully dissected and held out of the way.

Dr. DeWitt Stetten said that he had presented a similar case involving the femur before this Society November 12, 1919.

The patient originally came to him about nine and a half years previously with a fracture of the neck of the femur. X-ray examination showed a condition that looked like a cyst, involving the neck, greater trochanter, and upper part of the shaft. This was originally treated conservatively, but as the rarefaction increased operation was eventually decided upon and performed, and a tumor-like mass was removed which consisted largely of undifferentiated osteoid or chondroid tissue with cartilaginous islands of various size. He made a good recovery and was well for about six and a half years when he developed a recurrence. The process subsequently extended down the shaft of the femur and required a second operation, from which he also made a satisfactory recovery. About nine months later he sustained a fracture of the neck of the femur and six months after that a transverse fracture of the shaft. Both of these fractures united satisfactorily and since that time he has had no further trouble.

Doctor Douglas in closing said that regarding the X-ray treatment of these cases he had seen two cases where radiotherapy had been used, one involving the lower end of the radius, the other located in the femur. The one in the radius has been quite successful and has markedly diminished in size. The one of the upper end of the femur is considerably improved. The last patient presented here has been treated for a year and a half and Doctor Douglas said he believed re-operation would be necessary as the X-ray appears to have done little good. He had asked for an expression of opinion as to the advisability and danger of operating in this case as the process apparently involved most of the shaft of the bone; there had already been three fractures and one operation; and because the danger of injury to the musculospiral nerve was particularly great in view of the changes resulting from the conditions which had gone before. It seems, however, that the prognosis without operation justifies this risk.

SUBPHRENIC ABSCESS

Dr. Thomas H. Russell presented a man, thirty-eight years of age, who was admitted to the Post-Graduate Hospital October 25, 1921. He was operated upon for a perforated duodenal ulcer by Doctor Russell during the month of March, 1921. After the operation he made a satisfactory recovery and felt exceptionally well, gained forty pounds in weight and was not troubled with symptoms of stomach trouble, which he had suffered from for a long time before the operation. He remained well until six weeks before his reception into the hospital when he suddenly began to have pain in the upper right abdomen. The pain was stabbing and very severe, and was not influenced by food. He began to lose weight rapidly. Three or four days ago the pain became very severe and was much worse after taking food. No nausea or vomiting. He has had an irritating cough for several weeks. Pain is very severe when he coughs.

The chest examination is negative. There is muscular rigidity and a sense of fulness in the right upper quadrant of abdomen. Tenderness is present when the ribs are tapped over the right lower chest.

The X-ray showed subphrenic abscess. (The films have been destroyed.) With gas-oxygen anæsthesia an incision was made in the right upper quadrant of abdomen parallel to right rectus muscle, just as incision ordinarily used for gall-bladder operations.

Abdomen opened and explored. A large abscess was found in front of and above the liver extending down over the margin of the liver. With finger dissection the abscess was opened and pus removed by means of suction. Two rubber tube drains were inserted and wound closed with silkworm sutures. Patient made an uneventful recovery and was discharged from hospital November 23, 1921. He has been in excellent health since.

Doctor Russell presented a second patient, a man, thirty-five years of age, who was admitted to hospital July 25, 1919. He had suffered from pain in his right upper abdomen since the preceding July 12, on which date he was struck on the right side of lower chest and upper abdomen by a falling spring iron. There was severe pain at the time which subsided somewhat in a short while. The next day pain became worse and has gradually increased in severity. He has noticed fulness over right lower ribs. He coughs a great deal but cannot get relief by coughing. Cough is very painful.

Examination of chest negative. There is a decided fulness with tenderness and rigidity over the right costal margin and in epigastrium. Increased liver dulness which extends up to the third rib. There is sense of increased heat over right upper abdomen and over swelling in right lower chest.

Operation under gas-oxygen anæsthesia. Incision parallel to right costal margin down to peritoneum. Peritoneum stripped downward and fingers gradually inserted into abscess cavity extending above liver and below diaphragm. A large amount of thick yellow pus evacuated. Not foul in odor. Two rubber tube drains inserted. Dry dressing applied.

Culture Report.—Specimen shows numerous pus cells with irregular pieces of tissue about eight millimetres thick and resemble echinococcus cyst formation.

Microscopic.—Cyst wall shows hyaline lamellar structure of concentric rings similar to echinococcus cyst but no parasite found. Discharged September 30, 1919.

Doctor Russell presented also a man, thirty-five years of age, who was admitted to hospital June 30, 1921, complaining of pain in his epigastrium. The man had had pneumonia seven years ago on left side. He was operated

upon by Doctor Deaver, in Philadelphia, seven months ago for intestinal obstruction; a colostomy being performed in left side at that time. He was thought to have cancer of the bowel which proved to be inflammatory; then colostomy was closed. Six weeks ago was operated upon by Doctor Russell in the Post-Graduate Hospital for intestinal obstruction and general peritonitis—obstruction due to a band—no perforation found after careful search. Peritoneal cavity washed out with saline and drained. Patient in very poor condition. Prognosis bad. The man improved after this last operation but had a stormy convalescence. Was discharged from hospital eighteen days later in good condition.

Readmitted to Post-Graduate Hospital June 30, 1921, complaining of pain in right upper quadrant of abdomen referred to back and right lower chest. Nausea but no vomiting. Is losing weight rapidly and cannot eat. Feels very weak.

Physical examination reveals numerous râles in right lower base. Tenderness over liver region and right upper quadrant of abdomen. X-ray shows right diaphragm elevated and flattened with obstruction of the costophrenic angle. Absent illumination is seen at right base, this having a cup-shaped appearance bounded above by a straight line with a definite wave suggesting a hydropneumothorax, this probably encapsulated. The quantity of fluid is estimated at about a pint. Blood count 14,400, with 88 per cent. polynuclear cells; temperature 101°; pulse 118. Under nitrous oxide anæsthesia an incision was made in right upper quadrant of abdomen. A large subdiaphragmatic abscess was found on the right side. Abscess extends from upper surface of right lobe of liver to the suspensory ligament, then follows down to under surface of liver. Opened with fingers. Pus removed by suction. Rubber tube and cigarette drain inserted. Wound closed with silkworm gut. Pus shows pneumococcus. Patient discharged August 8, 1921.

SUBPHRENIC ABSCESS WITH SPECIAL REFERENCE TO TREATMENT

Dr. Thomas H. Russell read a paper with the above title, for which see page 238.

Dr. Howard Lilienthal said that he was more convinced than ever that the abdominal route is not to be preferred to the supraphrenic, but he tries to avoid entering the pleura. Doctor Russell had shown very clearly that thoracic complications are not uncommon in subphrenic abscess. Therefore, Doctor Lilienthal believes that by making an exploration above the diaphragm certain of these complications could be discovered in their incipiency. For example, empyema may have resulted from the perforation of a small subphrenic abscess. By the supraphrenic route such sacculated empyemas can be drained without infecting the general pleural cavity. The speaker operated, using local anæsthetic, by the following method:

The patient lies prone with a pillow underneath his abdomen and with his head lower than the location of the proposed incision. This posture was first recommended by Dr. Charles A. Elsberg. A portion of the ninth rib is subperiosteally resected, the pleura pushed away from the diaphragm and the subphrenic abscess then aspirated and drained. Supraphrenic collections of pus in the neighborhood of the subphrenic abscess will be found and can also be drained. If during the approach the pleura should be accidently opened, very little air will enter because of the posture of the patient. It is then pos-

sible to suture the upper edge of the pleura to the diaphragm at a distance from the wound of entrance so that a large area is exposed through which aspiration and then drainage can be accomplished. It has even been possible to use a rib spreader and thus thoroughly expose the phrenic dome. Exploratory puncture through the unopened skin is not advisable in these cases but with the exposure made as outlined above the needle may be used and one gets an idea from the density of the tissues traversed that the abscess is near. The mortality in cases treated by this method must be very low. If there is pain in reaching a low sacculated empyema it may be necessary to supplement the local anæsthetic with general anæsthesia. Once having entered a supraphrenic empyema it should be widely opened and the region toward the mediastinal side should be explored for these cases often form mesial empyemas connected with the supraphrenic.

To illustrate one advantage of the high approach Doctor Lilienthal briefly outlined the case of a young man who in the course of paratyphoid fever developed a subphrenic abscess which perforated the diaphragm and, going still further, involved the lung itself in the suppurative process. By the method here described it was possible to drain the lung abscess as well as the subphrenic.

From long experience in abdominal, as well as in thoracic surgery, Doctor Lilienthal expressed his conviction that, other things being equal, the shock following an operation for thoracic suppuration is less than that which is seen in similar abdominal infections. Drainage from below secured by dissecting up over the dome of the liver is by no means always satisfactory and counter drainage posteriorly must often be made.

Dr. Seward Erdman said that as Doctor Russell had so definitely condemned the commonly used method of draining subphrenic abscesses by approach laterally, between or through the ribs, and recommended an anterior, transperitoneal, drainage, it seemed unfortunate that Doctor Russell did not give the mortality in his series of cases.

In order to carry conviction that the abdominal approach was superior, a very convincing lowering of the mortality rate must be shown.

He thought Doctor Russell had included several cases of abscess following operations on the biliary tract where the local collection of pus or retained bile would naturally call for approach through the operative incision, and it would seem that there could be little difference of opinion about this.

But for true subphrenic collections well up on the superior surface of the liver, Doctor Erdman still believes that the lateral approach through the ribs afforded the most direct and satisfactory drainage and he felt that the exploratory needle used at the time of operation was most helpful in locating the pus.

On the Second Surgical Division of the New York Hospital a consecutive series of twenty-one operations for subphrenic abscess showed seven deaths (33 per cent.).

Sixteen of the cases were complications of other serious conditions:

11 cases of appendicitis with peritonitis (5 deaths)
2 perforated duodenal ulcers (2 deaths)
1 acute cholecystitis
1 suppurative pleurisy
1 splenic anæmia

It is seen that all the deaths occurred in cases where peritonitis was the underlying cause of the subphrenic abscess, and largely responsible for the deaths.

The remaining five cases were primarily diagnosed as subphrenic abscess; these were all drained through the ribs and all of them recovered; the needle was used in each of these cases.

Dr. Robert T. Morris said that in the group of cases suitable for abdominal approach there is one instrument especially useful and that is a big urethral sound. It is curved just right to curve up over the dome of the liver. When pus escapes a large, hard tube can be inserted, following this with the use of Dakin's solution. These cases will do very well under that sort of treatment.

Dr. John Douglas said as to the question of diagnosis in these cases Doctor Russell spoke of the gas which usually forms under the diaphragm. Gas usually does form in these cases when the infection is due to anaërobic bacteria. The bubble of gas which collects under the diaphragm with the patient in the erect position, or at the highest point with the patient lying on the side, is one of the greatest helps that he knows of in helping make the diagnosis. As far as the incision is concerned he doubted as to the particular advantage of an anterior incision. He remembered having a case where a subphrenic abscess formed after an appendix operation and he made an anterior incision and had great difficulty in keeping the tube in place for drainage. By a posterior incision and approach he believes, as Doctor Lilienthal has said, it can be done with very little or no more than a moderate amount of difficulty under local anæsthesia. He believed that if one does accidentally open the pleural cavity it is almost always possible to wall that off at the time and wait twenty-four hours before going into the abscess cavity

Doctor Russell, in closing, said he thought, summed up, the point is, all agree these abscesses come from intra-abdominal diseases and it seems strange to him to go through the chest to help a condition following an abdominal infection. In answer to question about mortality rate Doctor Russell replied that he had not intended to convey the impression that these cases at the Post-Graduate Hospital were all opened through the front; some of them were opened through the side. A review of these cases had been made to arrive at the causes of the abscesses. He has been able to communicate with six cases he operated upon through the abdomen and they are well today.

BRIEF COMMUNICATION

WREDEN'S METHOD OF RECONSTRUCTING VOLUNTARY ANAL CONTROL

DEFICIENT control of the sphincter ani is one of the most crippling disabilities with which we have to contend. Numerous operative procedures have been devised to restore this function. In general they have been unsuccessful, except where the sphincter is merely cut or torn in one place; here suture of the cut ends is all that is necessary.

In the more complicated cases where the sphincter is either destroyed or its nerve control lost, the problem is far more difficult.

Wreden, of Leningrad, Russia, described in the *Archives of Surgery* for March, 1929 (vol. xviii, No. 3), a plastic method for the restoration of anal control, which was applied by me with success in the following case:

CASE.—December 12, 1928, a man, forty years of age, reported at the office complaining of bleeding from the rectum. Two brothers had died of cancer: one of the stomach, one of the rectum. He has been bleeding for the past four months. Examination revealed, about five inches inside the anal sphincter, a hard, ulcerated mass which, under proctoscopic examination, was evidently a carcinoma. Wassermann negative.

December 17, 1928, under spinal anæsthesia, the rectum was dilated, and a small piece of tumor removed and subjected to microscopic examination. *Diagnosis.*—Adenocarcinoma. An immediate perineal resection was done, the sphincter being dissected free and cut only on its posterior aspect. At the close of the operation the cut ends of the sphincter were united by suture.

The post-operative recovery was uneventful; but following the operation there was at no time any rectal control. February 20, 1929, a circular incision was made around the anal orifice and an endeavor made to suture the sphincter. This manœuvre was completely unsuccessful and was followed by no improvement in control.

March 21, 1929, a plastic was done according to the method of Dr. R. R. Wreden.

1. Under spinal anæsthesia two strips of fascia, each eighteen by two centimetres, were removed from the fascia lata and placed in normal salt solution. The patient was then put in the lithotomy position.

2. Two vertical incisions were made on the right and left of the anal orifice, half way between the anus and the tubera ischii; these incisions penetrated to the aponeurosis, covering the muscles of the perineum.

3. The fasciculi of the glutei maximi were then exposed by means of two crescent-shaped incisions, with their convexity directed laterally and posteriorly.

4. The upper and lower ends of the two vertical incisions were then connected by undermining the skin between them. Two forceps were then introduced transversely through each of the vertical incisions of the perineum anteriorly and posteriorly to the anal orifice, the forceps both directed to the left.

5. The ends of one fascial strip, caught by means of two forceps, were drawn through the left vertical incision. The other fascial strip was drawn by means of two forceps in the opposite direction. As a result the lower end of the rectum was encircled by two fascial loops.

6. Two forceps were then introduced through each of the crescent-shaped incisions and the skin between the crescent-shaped and the vertical incisions undermined. The ends of the fascial strips were drawn through the crescent-shaped incision and securely fastened to the fasciculi of the gluteus maximus muscle of the opposite side, one strip above and one strip below the fasciculi, where they were fastened by chromic-gut sutures. The same manœuvre was repeated on the other side. The anal orifice was thus enclosed by a fascial ring. The strips were sutured at tension sufficient to barely permit the introduction of the index finger. The wounds were closed with silk suture.

Defecation was delayed for ten days after operation, by the administration of opium. The wounds healed without suppuration.

Following the first movement of the bowels, the patient was told not to exercise any attempt at control. An examination of the sphincter at this time revealed normal dimpling of the anus and a distinct fascial ring just inside the orifice. Three weeks after operation the patient was told to try to exercise control of the sphincter by movement of the gluteus muscles. Control improved as the muscles were educated to their new function.

At the present time, five weeks after operation, there is rarely soiling at night, and only occasionally during the day when the bowels are loose is there a slight soiling of the pad. The patient knows when the rectum is full and is usually able to reach a toilet in time to prevent soiling. As time goes on control will undoubtedly grow more perfect.

Two cases of this kind, with a slight modification of the Wreden technic, and the use of prepared fascia (Koontz'), in place of fascia lata, were reported by H. B. Stone, of Baltimore; one unsuccessful and the other successful. So far as I know this is the fourth case of this kind done.

J. Louis Ransohoff, M.D.
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BOOK REVIEW

DISEASES AND DEFORMITIES OF SPINE AND THORAX. By ARTHUR STEINDLER, M.D. 8vo.; cloth; pp. 573. St. Louis, C. V. Mosby Company, 1929.

Doctor Steindler, in his previous work on "Orthopedic Operations," and in other writings has always shown such painstaking detail in description and such smoothness in diction that one is led to expect his latest contribution to orthopedic literature to be both instructive and interesting. The general surgeon and medical practitioner also would do well to acquaint themselves with the many useful points which have considerable bearing on pathological conditions and derangements not orthopedic. Then, too, the book is replete with suggestions on diagnosis and treatment of all forms of injury and fractures of the spine.

In the first chapter on Congenital Deformities he carefully takes up the life history of the centres of ossification of the component parts of the vertebræ, and shows how this must be understood in order to study the pathogenesis of congenital deformities.

Abnormal behavior in these centres is the cause of many of the anomalies. They are classified under three heads: (*a*) Morphological variations; (*b*) numerical variations, and (*c*) errors in regional differentiation. Under the first heading belong half vertebræ, wedging and fusing of vertebræ. The second includes increase or diminution of the number of vertebræ in each segment, and the approach in characteristics of a vertebra to those belonging to the adjoining segment—the most frequent example being the sacralization of the fifth lumbar vertebra. In the third class are the anomalies due to suppression of parts of the vertebra. This is most frequently seen in the posterior segment. Here the author discusses spina bifida occulta, stating concisely the pathology, peripheral symptoms, X-ray findings and treatment. The X-ray has shown a more frequent incidence of a spinal cleft, and it has been found that peripheral deformations such as club foot and claw foot may result. The differentiations between the symptomless cleft and the one producing anomalies are well brought out. Spondylolisthesis is included properly in this classification because due to incomplete ossification of the neutral arch except, occasionally, where following a fracture. This chapter is profusely illustrated with photographs and X-rays, and the latter show what is intended, which is not always the fact in medical literature. The same good photography is in evidence through the succeeding chapters. The cervical rib is given the considerable space it deserves in differential diagnosis and indication for operative procedure. Rare deformities and malformations of the thorax, congenital, follow, and the chapter is closed with a comment and a very complete list of references, and the same with each of the ten chapters.

Chapter two deals with static anteroposterior deformities of the spine—a very readable presentation of the subjects of posture and visceroptosis; and the static constitutional deformities of rachitis and osteochondritis. The literature of posture is abundant, but the author's picture by word and photograph of the varied types, tall and slender, short and heavy, and normal anatomic types and their behavior in faulty posture, and the relations between posture and visceroptosis, is very clear. Then he takes up the treatment by exercise and mechanical support. There is a short discussion of osteochondritis and vertebral epiphysitis.

The third chapter, with seventy pages of reading matter and over twenty of illustrations, deals minutely with the anatomy, mechanics, and dynamics of the normal, and scoliotic spine—followed by the pathogenesis and classification. In the diagnosis and treatment, stress is laid on the prescoliotic stage, in which the "postural and attitudinal anomalies first begin to appear," and where the most effective work can be accomplished. All methods of treatment from those of the ancients up to those of the present day, by gymnastics, apparatus, supportive and corrective appliances, surgical, and his own technic of treatment by compensation, are stated in clear detail. Fractures and dislocations of spine and thorax in the fourth chapter are concisely classified, but dealt with more briefly than the larger subject of scoliosis.

The fifth chapter is devoted entirely to low back pain—one of the most frequent, as well as most difficult, disabilities coming to the physician. The subject is treated anatomically, mechanically and pathologically as clearly as the intricacies of the condition permit. Fully half the chapter on tuberculosis of the spine is given up to treatment by recumbency and heliotherapy, plaster jacket, and operative fusion. Opinions of many writers, American and foreign, besides the author's, on the relative value of conservative and operative methods, will show the reader the diversity of practice among specialists and provide much food for thought. The operations are well described and illustrated.

The different forms of osteomyelitis and syphilis of the spine occupy much less space, as of less frequent occurrence. Chronic arthritis and tumors, followed by the appendix, providing a synopsis, complete this most interesting and instructive work.

CHARLES DWIGHT NAPIER

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